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EVALUATION OF ATTITUDES RELATING TO TEACHING.
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AFFECTIVE BEHAVIOR TESTING INSTRUMENTS KNOWN AS Q-SORTS WERE DEMONSTRATED IN A COMPUTER-ORIENTED APPROACH TO THE ASSESSMENT OF PERSONAL TRAITS, VALVE SYSTEMS, AND SELF-CONCEPTS OF THE ROLE OF A TEACHER. DURING TWO SEMESTERS, Q-SORTS WERE ADMINISTERED TO 351 STUDENT TEACHERS, BEGINNING ELEMENTARY TEACHERS, AND MASTER TEACHERS IN EIGHT GROUPS. STATISTICAL PROCESSING OF Q-SORTS WAS LARGELY ACCOMPLISHED BY MEANS OF COMPUTER PROGRAMS DESIGNED ESPECIALLY FOR THE STUDY. RESULTS WERE PRESENTED AS RELATED TO THE INDIVIDUAL, GROUP, AND METHODOLOGY. FINDINGS SHOWED THAT IT WAS POSSIBLE TO ASSESS THE AFFECTIVE BEHAVIORS AND CHANGES IN AFFECTIVE BEHAVIOR OF STUDENT TEACHERS DURING THEIR TEACHING APPRENTICESHIP. IT WAS SUGGESTED THAT THE INSTRUMENTS AND METHODOLOGY OF THE STUDY COULD BE USED BY EDUCATORS TO ASSESS SUBJECTIVE MATTERS. (JM)

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EVALUATION OF ATTITUDES RELATING TO TEACHING

Cooperative Research Project No. S-007

by

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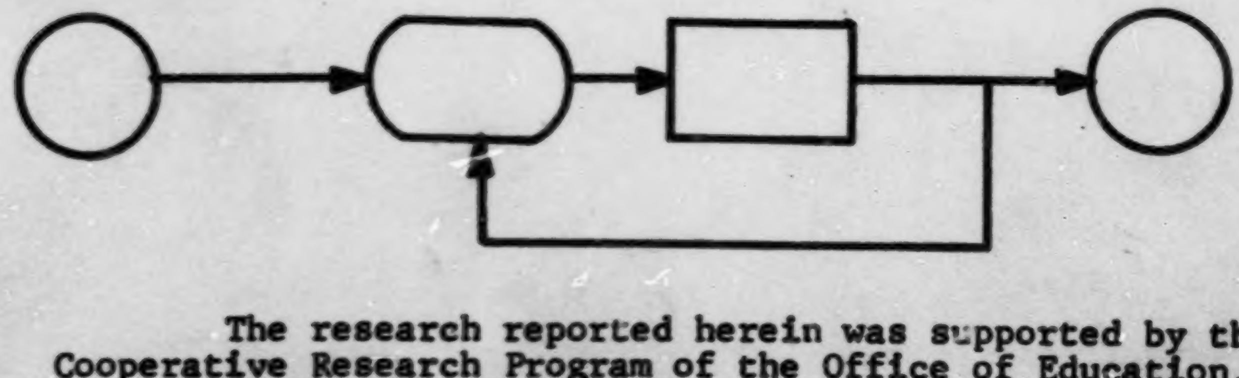
1964



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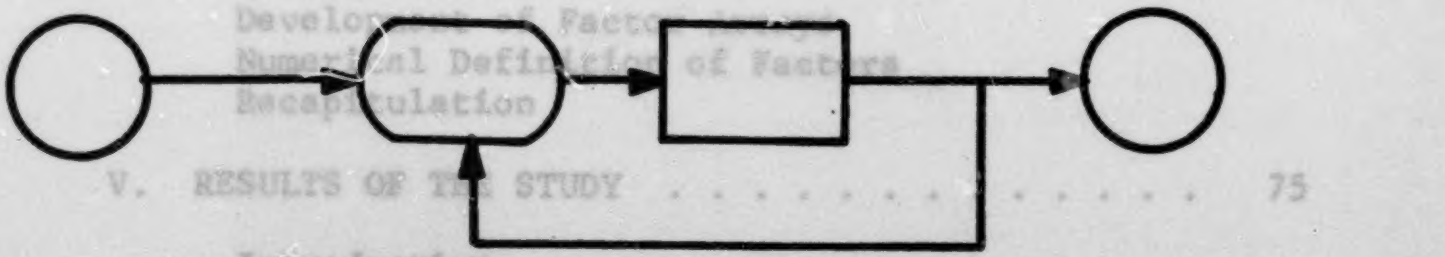

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CHAPTER I

EVALUATION OF ATTITUDES RELATING TO TEACHING

Background to the Consideration of Attitudes Relating to Teaching

Considerable success has attended the efforts of educators in evaluating the effectiveness of instruction in what is known as the cognitive domain of human behavior. Somewhat less success has been achieved in the implementation and assessment of educational objectives in the affective domain. The substantive portions of published educational objectives include components of affective derivation, such as matters pertaining to appreciations, attitudes, interests, and values. It is the educator's task to implement these objectives in a curriculum. It is a general expectation that, as a consequence of the pupil's exposure to the curriculum, and in the course of his character development while in school, he will learn to respond and act in ways desired by his society.

In a study of affective behaviors in persons preparing for service in a profession, such as teaching, the concern is with subjective matters in a very specific sense. The specific nature of such a study relates to consideration of how the novice will adapt to a relatively new social situation in terms of his own internal evaluative system. It is to the specific domain of affective behaviors in novice teachers that this study is addressed, with the expectation that new perspectives on the identification and assessment of variables of importance in the domain will evolve.

The difficulties attending any investigation into problems in the affective domain of human behavior are well known. A taxonomy of educational objectives that relates to this domain states that it is a virtual "Pandora's Box," but that it must be opened (54:91). The real problem for the teacher or the researchist may be one of strategy; for the teacher it will be one of teaching strategy, and for the researchist it will be one of strategy that attains the most at the point of testing hypotheses. There appears to be much fixation in the path which research strategy must proceed, possibly due to the traditional reverence given to what is known as the doctrine of individual differences, or R-methodology. For example, an accurate statement of the conditions under which an assessment of cognitive variables and personality variables should follow are accurately given in reviews of research strategies applying to each, but the procedure always seems to dictate that measurement of individual differences is fundamental.

Q-methodology (76) affords the researcher into educational problem areas of affective derivation a new perspective, and the promise of a different strategy that will offer much at the point of testing. The Q-methodology of research is patterned after Stephenson's development of intra-individual differences. Q requires a distinctly different orientation from that involved in the traditional concept of psychological measurement. A representative statement of the latter is given by Thurstone, in his development of the concept of inter-individual differences applied to multiple factor analysis (84:63).

It will become apparent, after some study and comparison of the two systems, that there are no natural, intrinsic, truth bases for either R or Q. Both rest on systems that are man-made schemes, just as the postulates of Euclidean geometry, and both schemes serve to unify and aid in the comprehension of certain classes of human behavior. Both systems might be said to be representative of one basic postulate each. Thurstone postulates that abilities are the primary causes of individual differences in overt accomplishment, and he specifies one fundamental postulate that supports this primitive idea. Together with a set of definitions and assumptions, he developed the factorial method that presents the mind as a dynamical system that is said to be understood in terms of a finite number of parameters. Stephenson says that in Q, intra-individual "significances" alone are postulatory, and that R and Q are to be regarded as independent systems (76:51). Q-methodology is further described as a new set of operational principles collected together that support this postulate.

Thus, a different strategy of research is available for probing into aspects of human behavior. Objectivity, reliability, and validity are pervasive concepts that characterize the nature of the probe in any methodology, and which must receive due attention in the instant study. While the tradition of testing after what is known as

R-methodology has produced significant results in assessment of cognitive behaviors, it must be recognized that it has failed to produce commensurate results in the assessment of affective behaviors. It may be suspected that the probe, that is characteristic of R, by "observations of X's behavior by Y," would fail in the case that calls for "self-reflection of X." One of the consequences of applying R and Q in areas where each is appropriate is the realization that two different probes of human behavior are often needed, and the circumstances under which these two different probes operate with highest reliability are also different. It appears logical that consideration may be given to a basis for appropriate uses of both systems in the same investigation, as it would certainly be preferable to any biased effort to support one or the other system, to the exclusion of benefits that might be realized from using the concepts of both.

Such are the preliminary considerations and background that were felt to be important in proceeding with the study of attitudes relating to teaching.

The Formal Statement of the Problem

In this study certain questions pertaining to the affective behaviors, and centered on the performances of student teachers, have been examined during a period of student teaching, to ascertain answers to the following general questions:

1. Can affective behaviors relating to education and teaching be assessed in student teachers during their teaching apprenticeship?
2. Can changes in affective behaviors relating to education and teaching be assessed in student teachers during their teaching apprenticeship?

The questions investigated rest on the assumption that during a teaching apprenticeship, a novice teacher experiences a changing set of affective behaviors with respect to education and teaching, as represented in his appreciations, attitudes, beliefs, interests, and values.

Answers to specific aspects of the general questions were sought by means of what is known as the Q-methodology.*

Secondary purposes of the study were to demonstrate the extension of the questions to others in the field of education, and to illustrate possible ways of utilizing computer technology in the processing of data pertaining to the solution of problems relating to affective behaviors. By the combination of a computer oriented approach to the assessment of affective behavior, utilizing known techniques of data processing and the procedures of Q-methodology, it was believed there would be provided a valuable research system.

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*A complete statement of the procedures which characterize this methodology is found in Stephenson's The Study of Behavior (76). This book forms the principal reference source for the conduct of this study.

Statement of Hypotheses

General Hypotheses

The following hypotheses are general in nature and were not posed to be tested for their general implications, but formed a basis for formulation of singular hypotheses; the latter were resolved in the manner of Q-methodology.

General proposition 1. Affective behaviors, relating to education in general and to teaching in particular, can be assessed reliably by Q-methodology in student teachers while they are serving their teaching apprenticeship. The hypothesis is assumed to be capable of extension to other persons in education, such as master teachers.

General proposition 2. Changes in affective behaviors, relating to education in general and to teaching in particular, can be assessed reliably by Q-methodology in student teachers serving their teaching apprenticeship. The hypothesis is assumed to be capable of excension to other persons in education, such as master teachers.

Theory of the Q-sort Testing Instrument

Before formal statements are made of singular hypotheses derived from the foregoing general hypotheses, it is desirable that a brief description of the nature of the testing situation and the theory built in the Q-sort testing instruments be given, because principally these matters are inextricably interwoven with the theory being tested.

Q-sort design. The basic raw data, when Q-methodology is employed, are derived from the Q-sort arrays rendered by the experimental subjects. The operation of sorting involves a reading of a structured set of statements, which are presented to the sorter in a random order. The examinee is instructed to rank order the statements into a fixed quasi-normal distribution, which portrays their relative significance to him. The sorter's order of the statements is then analyzed statistically. The analysis constitutes the assessment of the affective behaviors under study. The overall structure of the set of statements is directly related to the research design, described in the next paragraphs.

Two Q-sort designs were developed, designated as design I and design II. Both designs employ a 2 x 3 Fisher (27) factorial design, in which there are two main effects or factors, with two levels in factor A (educational philosophy) and three levels in factor B (matters pertaining to school operations). Figures 1 and 2 portray the designs in paradigm form.

The experimental person is unaware of the instrument design to which he is being subjected. He works under the direction of the sorting instructions, that is, he arranges the statements in an order of importance to him, guided by his set of values and attitudes.

In order to ensure that experimental subjects would have a commonality of attention to the Q-sorts, one set of instructions was used to motivate the sorting behavior. Instructions to the experimental persons were as follows:

> The pack of statements (in the Q-sort) contain descriptions of matters pertaining to education. You are invited to arrange the statements in a special kind of rank order. Basically the rank order is an order of importance, or significance, to you, in your role as a teacher in the classroom situation in which you are now serving.

Other instructions given to experimental persons were of a mechanical nature, e.g., how to get started, how to lay out pile cards, and how to reassemble the pack of statements comprising the Q-sort for acceptance by the computer.

Q-sort statements, authored to support the designs described in the following paragraphs, comprise the basic unit of the Q-sort instrument. In the instant study there are 54 statements to a pack, which were reproduced on standard-size, square-cut, blank computer data cards, size 3-1/4 x 7-3/8 inches. Each card is key-punched with coded data for use in computer programs designed for the analysis. Each statement contains two components of semantic content, one component in support of a kind of educational philosophy, and the other describing an aspect of teaching activity in implementation of the objectives of the school. The 54 statements represent specifications of six cells of a design, and where each cell has 9 replications.

Q-sorting involves the mental behavior in evaluative interaction by the experimental person with the factors and subdivisions of factors. The basic semantic content of both Q-sort designs pertains to education, much of which is chosen and paraphrased from sources in educational literature. Both Q-sort designs are of the conventional factorial type found in Q-sorts. Guiding concepts which helped in completing the designs semantically are given in the next chapter.

FIGURE 1

ILLUSTRATION OF Q-SORT DESIGN I

Independencies	Levels
A: Education Philosophy	a: Permissive c: Authoritarian
B: School Objectives	d: Academic objectives e: Social objectives f: Vocational objectives

FIGURE 2

PARADIGM FORM OF Q-SORT DESIGN I

A: Education Philosophy

	Permissive a:	Authoritarian c:	
B: School objectives	cell ad	cell ce	d: Academic objectives
	cell ae	cell ce	e: Social objectives
	cell af	cell cf	f: Vocational objectives

FIGURE 3

ILLUSTRATION OF Q-SORT DESIGN II

Independencies	Levels
A: Education Philosophy	a: Permissive c: Authoritarian
B: School Operations	d: General cultural aspects e: General school objectives f: Aspects of learning and teaching in the classroom

FIGURE 4

PARADIGM FORM OF Q-SORT DESIGN II

A: Education Philosophy

	Permissive a:	Authoritarian c:	
	cell ad	cell cd	d: General cultural aspects
B: School Operations	cell ae	cell ce	e: General school objectives
	cell af	cell cf	f: Aspects of learning and teaching

Singular Hypotheses

Singular hypotheses are the focal points for investigative effort, and are derived from the general propositions that have initially motivated the study. Singular hypotheses are divided into three categories: (1) hypotheses pertaining to individuals, (2) hypotheses pertaining to groups in a variate design, and (3) hypotheses which are methodological in nature.

Hypotheses pertaining to individuals

1.1 Experimental persons in all groups considered, in a majority of cases, will render statistically significant correlations for a teaching type.

This hypothesis provides certain basic data for other aspects of the study. Its determination will depend on other hypotheses having an affirmative assessment, in the following ways: teaching types will be defined by empirically derived factor arrays for each Q-sort design, which conform in general with the expectations given in the factorial representation. Correlations, constituting an index or congruence with the empirically derived factor arrays, will constitute a measure of extent and direction of individual predilections. The sensitivity of Q-sorts as indicators of individual predilection in affective matters is a fundamental matter at issue in this hypothesis.

1.2 The analysis of Q-sort arrays for an individual on Q-sort design II on two occasions, separated by a suitable time interval, will reveal the nature of change of predilection of the individual. The statistics for assessment of this hypothesis will rest on correlations of individual's Q-sort arrays with empirically derived factor arrays representing teaching types. Changes in correlations from one administration of the Q-sort to the next will be tested for statistical significance by methods illustrated in Chapter IV. Under conditions of the study the change is attributable mainly to the teaching experience in which the individual has participated in the time interval.

Hypotheses pertaining to groups

2.1 The assembly of Q-sort arrays from a homogeneous group will permit the definition of a modal array that will reveal the nature of the predilection of the group as if it were a representative person.

2.2 The assembly of Q-sort arrays from a homogeneous group on two occasions, separated by a suitable time interval, will permit the definition of modal arrays which will reveal the nature of change of predilection occurring within the group.

2.3 Changes in predilections in novice groups, identified in Figures 5 and 6 as X_1, X_2, X_5, X_6, X_7, and X_8, as revealed through comparisons of two performances of these groups on Q-sort design II, will be in direction of a deepening of appreciation for statements bearing on teaching and learning. That is, the change will be shown to be a statistically significant shift towards appreciation of level "f" of the factorial design effect bearing on school operations. Q-sort design II is expected to have the sensitivity to reveal this kind of change, both for individuals and for groups. The nature and degree of the anticipated change is rationalized as having a direct relation to the extent of responsibility that each novice individual, and each novice group, has been assigned in the classroom. More specific research hypotheses may be represented in the following paradigm:

H_1: $X_5 > X_2, X_1$ (1963 series)

H_2: $X_8 > X_7 > X_6$ (1964 series)

The research hypotheses H_1 and H_2 are contained within the scope of hypothesis 2.3, and indicate the relative significance that each group will have to each other in terms of their deepening of appreciation for matters bearing on teaching and learning.

Hypotheses which are methodological

3.1 In order to form an adequate basis for proceeding with the testing of singular hypotheses relating to the psychological areas of interest, it will be necessary to perform the following: (1) construct a statement of theory of teaching and learning behavior in general terms, and (2) construct a statement of procedures relating to the operational aspects of testing in the affective domain of human behavior.

This hypothesis is answered in a theoretical sense, and is posed as a necessary condition for proceeding with the investigation.

3.2 Semantic validation of Q-sort statements can be accomplished by application of "information theory" (2). The improvement in the semantic validation of a Q-sort can be assessed in quantifiable "bit" measures, and by small sample theory. That is, when a Q-sort design is subjected to the process of validation at least twice, with appropriate editing intervening, the improvement in relevant semantic content can be assessed by means of statistical inference, small sample theory t-test, and in terms of units characteristic of information theory.

3.3 A system of data processing, using computer technology, can be devised which carries on all computations characteristic of Q-methodology. The devisement of such a system is considered essential for making Q-methodology a practical matter in education, either for instruction or for research.

3.4 Factor analyses of Q-sort arrays assembled from performances on designs I and II will reveal patterns of predilections of experimental persons, supporting in general the a priori expectations from analyses of variance of the same performances.

3.5 Factor analyses of Q-sort arrays assembled from performances on design II will enable the statement of empirical definitions of correlates of the permissive and authoritarian teaching types with the factor of school operations, and expressed in particular in terms of the classroom behavior of the teacher.

Nature of the Research

The definition of any method of research is gained in terms of the conditions under which it is conducted. Since no attempt was made to control or influence the events attendant with the social situation in which the experimental persons were acting, this research may be classed as a kind of status study. That is, the research is a study of what naturally exists in a student teaching situation. The wide use made of correlational coefficients and factor arrays of teaching types identifies the study with what is commonly called a correlational study. Certain singular hypotheses are based on the expectation of experimental persons being classed in one of the syndromes of teaching types by means of correlation coefficients. In terms of a taxonomy of experimental design, as outlined by Campbell and Stanley (11:177), the study classifies in part as a five-group, pretest-posttest design in the 1963 series, and a three-group design of the same type for the 1964 series. In the paradigm in Figures 5 and 6 the pretest-posttest design presents useful information as to the general conduct of the research, including the time sequence of events occurring during one semester of teaching by each group of experimental persons, during which time they participated in a schedule of Q-sorting. In Figures 5 and 6 the "X" represents the exposure of a group to an experimental event or variable, the effects of which are to be assessed in this study. Teaching experience is the common environmental characteristic of the eight groups, and each group has somewhat different circumstances attending. The entry "O" refers to the process of observation through Q-sorting. The left-to-right dimension in the paradigm of events indicates the time sequence through the teaching semesters of 1963 and 1964. The entry "T" in Figure 6 refers to a reading comprehension test given to the three groups in February 1964.

The Q-sort testing instruments in Figure 6 are essentially parallel forms of the testing instruments in Figure 5. The parallelism means that the designs and statistical efforts in analyzing the derived factor arrays are identical, but that the semantic content is somewhat different in certain ways. The Q-sorts in the 1963 series, indicated in Figure 5, were completely revised to make the statements shorter and to have sharper statement of content. The revised Q-sorts were re-validated and used in the 1964 series, indicated in Figure 6.

FIGURE 5

ILLUSTRATION OF SEQUENCE OF EVENTS AND NATURE OF STUDY 1963 SERIES

Comparison Group	X: Teaching Experience					
Elementary School Student Teachers	X_1	O_{II-1}		O_I	O_{II-2}	
Secondary School Student Teachers	X_2	O_{II-1}		O_I	O_{II-2}	
Elementary School Master Teachers	X_3	O_{II-1}			O_{II-2}	
Secondary School Master Teachers	X_4	O_{II-1}			O_{II-2}	
Elementary School Beginning Teachers	X_5	O_{II-1}		O_I	O_{II-2}	
Time Sequence		2/63	3/63	4/63	5/63	6/63

In the above notation, O_I refers to application of Q-sort design I; O_{II-1} and O_{II-2} indicate the first and administrations of Q-sort design II. The subscripts to X refer to the particular teacher groups.

FIGURE 6

ILLUSTRATION OF SEQUENCE OF EVENTS AND NATURE OF STUDY 1964 SERIES

Comparison Group	X: Teaching Experience				
Pre-Student-Teaching Group	X_6	T_6	O_{II-1}	O_I	O_{II-2}
Secondary School Student-Teachers	X_7	T_7	O_{II-1}	O_I	O_{II-2}
Elementary School Beginning Teachers	X_8	T_8	O_{II-1}	O_I	O_{II-2}
Time Sequence		2/64	2/64	3/64	5/64

In the above notation, T_6, T_7, T_8 refer to a test of reading based on the Q-sort statements and utilizing information theory. The O_{II-1}, O_I, and O_{II-2} refer to application of Q-sort designs as in Figure 6a, with the following differences. The Q-sorts used in events X_6, X_7 and X_8 were reconstructed instruments from those used in events listed in Figure 6, and are, in effect, parallel forms.

CHAPTER II

DEVELOPMENT OF THEORY

General Considerations

Toward an Adequate Theory of Behavior Relating to Educational Research

An ultimate theory of behavior for educational research may never be attained, in that such a theory will serve to explain all of the behavioral phenomena encountered. It is reasonable to suppose that an adequate theory of behavior can be kept in process of development which continues to offer explanations of specific situations observed in the educational environment.

The pattern of assumptions and procedures that are presented herein are intended to transform certain statements of educational objectives from an achievement oriented connotation, so as to serve for the specific research procedures appropriate for this study, and to involve an operational orientation. The system of procedure is tentative in its guidance of the research, and is acceptable only as long as it appears to help explain observable facts, and apply adequately to the given educational problem areas.

The following statement of procedures is intended to be an assembly of research operations which seem to lend themselves to study of the student teacher problem in particular, with some implications for the assessment of affective behaviors in education in general. They include consideration of the main postulate of Q-methodology pertaining to intra-individual differences. In the fixed symmetrical format of distribution of statements in a Q-sort the relative position of each statement operationally defines its significance under the given conditions of sorting instruction. The significance which a person accords each statement provides the basis for the fundamental transitory relation that is a necessary assumption for correlating arrays between persons and with empirically derived factors.

Procedural Aspects of Student-Teacher Problem

1. Teaching and learning behavior is considered to be a pervading process characteristic of the objects of investigation in education, namely, of teachers, students, parents, and interested citizens. Behavior may be described in unobservable components, such as intellectual (covert), or expressed openly for all to observe (overt), but all phenomena to be considered is behavior, encompassing the well known definitions of it, such as cognitive, psychomotor, and affective. The unit of behavior is man X, whether teacher, student, parent, or citizen, appropriate for the environment Y, and the mediating circumstances Z. The XYZ paradigm is a basic consideration in the research design in this study, adapted from Stephenson's use of the concept (77:19).

2. The characteristics of behavior, which are expressed in the form of intra-individual significance, form the main indicator of uniformities in human conduct in learning and teaching. A derivative of this postulate is the following proposition that forms the a priori reason for some connection to exist between a significant order of matters, such as the rank ordering of predilections on a set of ideas, by two persons, or by the same person on two occasions (53:423):

2.1 If a person X is presented a set of propositions for consideration, under conditions such as for a given social environment Y, and under certain mediating circumstances Z:

Then that person will tend to rank order the set of propositions, transitively, and in a manner uniquely significant to him.

3. The various ways of estimating behavioral patterns, or communalities, identified among individuals in a relatively homogeneous grouping, by factor analysis or other statistical procedures, result in a typological classification system of behaviors. Empirically derived descriptions of the behavioral patterns serve to form a basis for correlations of individual performances. Since there is a typological element inherent in any kind of psychological classification, the following specific characteristics of typology in this system will be used:

3.1 The tools of typology lend themselves to the practical necessity that investigative efforts in education contribute explanations in behavioral terms. The operations of teaching-types, which are most productive of explanations, are those that bring into similar significance those statements and ideas pertaining to adequate teaching behavior. The statements and ideas may be presented in some random order, and the operations will involve the reconstruction of the dispersed order into meaningful continuities and interconnection of elements.

3.2 The typification of behavioral patterns found in experimental persons lend themselves to interpretations and explanations, when augmented by other information. For example, the more rigid a teaching type, the more deeply does it appear that its representative show evidence of certain specific kinds of teaching stereotypy. Conversely, the individual may be opposed to standardization. In any event "typology," which is a scheme of behavioral syndromes, is organized to fit as naturally as possible the empirically derived data, with the main concentration on the study of patterns that are educationally significant.

3.3 The teaching syndromes that are developed empirically are subject to continuous theoretical critique and redefinition.

4. Research design in education requires an adequate representation and assessment of related interacting variables within a given teaching-learning situation. The variables are restricted to aspects of behavior, considered as processes, and expressed in operational terms. That is, what one does under certain social circumstances, and under certain conditions of motivation. The aspects which have been considered in terms of abilities, or in terms of dynamic potential to behave, are subordinated to their operational sense. In more specific terms, the following apply:

4.1 A basic operational relation exists between forms of overt and covert behavior, both in the learning and teaching processes. A similar kind of relation is presumed to hold between the classes of behavior broadly classified as affective and cognitive.

4.2 The Q-sort, which is the instrument of Q-methodology, provides a self-description of person X's behavioral pattern, under social conditions Y, and mediating circumstances Z. The data are the operations of experimental persons on the Q-sort. The self-descriptions are characterized by the uniqueness and centrality of the experimental person.

The Fisher model considered. The Fisher (27) design of experiment has become a standard throughout the world, and its application to problems of education is well illustrated by such men as Kempthorne (50) and Snedecor (74). The Fisher theoretical model subsumes the theory of the student-teacher problem in this study, in a manner specified by Stephenson (76:66). The procedure is to structure a sample of statements by applying Fisher's methods of experimental design to the sample. The statements constitute the sample in a statistical sense, and the structuring of the statements to conform with a design provides for the representativeness of the sample of statements.

The plan here is to develop a balanced factorial design which, when represented in the form of selected statements, will provide a testing ground through the use of factor analysis and analysis of variance. The whole of a theory can rarely be represented in a Fisher design; therefore, the experimenter will of necessity discriminate from among the many factors which bear on the problem. Following selection of the theoretical design of an instrument, or Q-sort, statements are assembled into the factorial design on that theoretical basis, with certain precautions taken in matters about their conciseness, clarity, and genuine representativeness. In the abstract design of Q-sorts are defined certain effects, or independencies, such as A, B, C . . . , with levels a, b, c . . . , respectively. Without replication in a balanced block design there are axbxcx . . . combinations, one level at a time for each effect. If these are replicated, say k times, there will be kxabc . . . such combinations. This constitutes a definition in an abstract sense of a structured sample, to consist generally of a set of kabc . . . cases in balanced design.

The importance of the structured sample and its relation to the theoretical considerations of the problem being investigated in this study require that realistic planning be accomplished in the selection of statements Q-sorts. A major difficulty in the matter may lie in the authoring of appropriate statements with which to fill out the design; this matter is discussed in a later section, under the subject of validation. In this case, validation is construed to mean semantic validation, and utilizing information theory (2) for the statistical analysis.

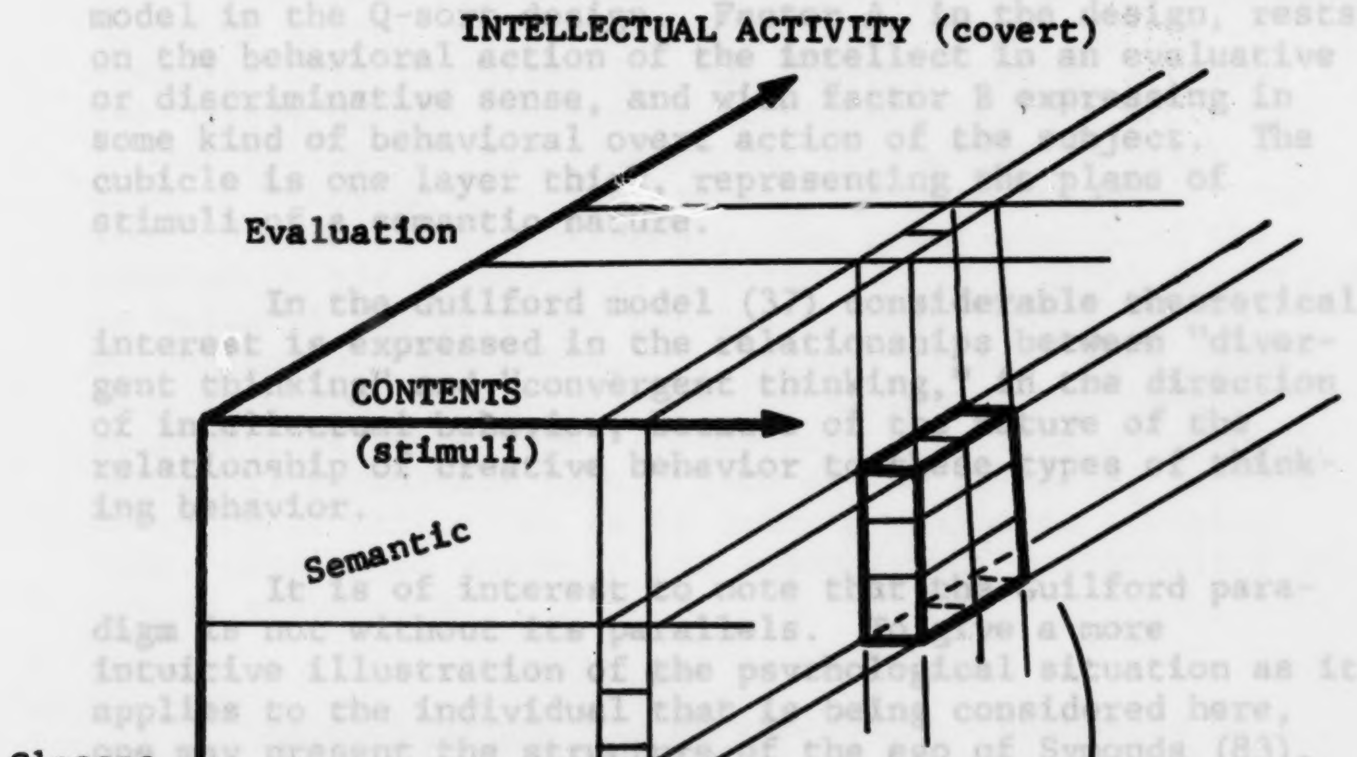
Guilford model of intellect considered. Consideration of the Guilford model of intellect brings a psychological approach to the problem of "abducting" on the student-teacher problem of this study. Guilford (37:3) states that the model has been used as a basis for systematic orientation with respect to psychological tests. This, it is felt, can be extended to consideration of Q-sort designs. It is relatively easy to use the model heuristically, whereby the framework is used to present aspects of the educational problem being held in mind. By some manipulation the model will also serve to identify aspects of the Fisher design presented in the previous sub-section. Reference to the paradigm in Figure 7 serves to illustrate the following discussion.

The specifications for the Q-sort include discrete semantic stimuli with behavioral content, in the form of structured statements. These are brought to bear on a psychological situation, bringing about both overt and covert types of responses by an individual. In the Guilford model the overt responses are observable as "products," and the covert responses are called "intellectual activities." The stimuli, or "contents" dimension of the Guilford model, take the form of a set of statements, one to a card, authored to present some part of the theory. Statements are presented in random order, so that no systematic arrangement or contingencies will be apparent to the experimental subject. By the exercise of a suitable independent variable, in the form of an instruction to the experimental person, there is imposed a necessity for setting his determining tendencies, or response functions, into action. This results in many acts of discriminations, overtly expressed in the rank ordering of the stimuli as products.

In the Guilford model (illustrated in part in Figure 7), the cubicle represented at the intersection of three planes (that is, in the joint combination of classes, contents, and intellectual activity) constitutes the combination of psychological interest in theory. In the Guilford method of identifying factors, efforts are made to devise tests which will reveal whether there is evidence of the factor in an operational sense; this is determined by factor analysis. In the theory relating to education, as developed in this study, the effort is made to use the cubicle as a model for consideration of interaction of the two forms of teaching behavior with the stimuli. The

FIGURE 7

A PARADIGM FOR ILLUSTRATING RELATIONSHIP
BETWEEN GUILFORD MODEL OF INTELLECT
AND FISHER DESIGN IN A Q-SORT


INTELLECTUAL ACTIVITY (covert)
Evaluation
CONTENTS
(stimuli)
Semantic
Classes
PRODUCTS (overt)
Factor A
Factor B

particular levels to be included in the design, identified in psychological and educational terms pertinent to the student teacher problem, have already been discussed in Chapter I; these concepts were preceded by the kind of thinking that is illustrated in consideration of the Guilford model. The cubicle in Figure 7 may also be conceived as constituting a basis for the analysis of variance model in the Q-sort design. Factor A, in the design, rests on the behavioral action of the intellect in an evaluative or discriminative sense, and with factor B expressing in some kind of behavioral overt action of the subject. The cubicle is one layer thick, representing the plane of stimuli of a semantic nature.

In the Guilford model (37) considerable theoretical interest is expressed in the relationships between "divergent thinking" and "convergent thinking," in the direction of intellectual behavior, because of the nature of the relationship of creative behavior to these types of thinking behavior.

It is of interest to note that the Guilford paradigm is not without its parallels. To give a more intuitive illustration of the psychological situation as it applies to the individual that is being considered here, one may present the structure of the ego of Symonds (83), which resembles the structure of intellect. Ego is defined by Symonds as that phase of personality which determines adjustment to the outside world in the interests of satisfying inner needs. His statement of the dynamics, which might be implied in the Guilford paradigm, is contained in the following:

> The ego has three distinct elements: one perceiving (ego as the knower); two, thinking (ego as the thinker); and three, acting (ego as the doer or the executive or the will). In short, the ego first of all receives impressions from the outside world, then organizes these impressions so as to form a plan of action, and finally executes this plan of action in order to bring about desired satisfactions. (83:361)

Guiding Concepts in Q-Sort Construction

General Consideration of Teaching Types Applied to the Q-Sort Designs

Certain brief statements can now be made of guiding concepts useful for understanding and developing the research Q-sort designs for the student-teacher problem. The nature of the designs requires that aspects of educational philosophy and educational operations be brought into interaction in the Q-sorting. Within the broad concept of educational philosophy, the relationship of the teacher to his students is a basic thought, often described as being of two or three distinguishable types, such as authoritarian, democratic, or laissez-faire. Each statement in Q-sort design I or design II contains a semantic component of educational philosophy, either of an authoritarian or permissive type. Each of the following guiding concepts is written so as to infer a realistic teaching type, serving to guide in the assembly and construction of Q-sort statements.

Authoritarian. In an emphasis on standards of conduct and leadership, the teacher-authoritarian stresses the importance of established standards as promotive of harmony and security in human relationships. He believes in strong personal leadership in positions of social responsibility, and the necessity for solid preparation to meet the challenges of life. He stresses the disciplined action of the human mind, and he would apply sanctions to insure stability in organization, of which the classroom situation is an example. Teacher is the director of learning. Statements which are contained in the Q-sort, in designs I and II, and which contain an authoritarian component, are worded such that person inclined to implement the above in his teaching work will find an appeal in the statements. Operationally, this means that in Q-sorting, statements of the authoritarian aspect will gain higher significance than permissive statements.

Permissive. The permissive teacher is adaptable to changing circumstances; he is not afraid to make mistakes and profit by them; he is emancipated from external opinion and control to a large extent; and he takes self-initiated action. He is impartial in his dealings with the ranges of individual differences he encounters in others; he resists conformity or standardization of conduct. He would have the persons who work with him (such as pupils) consider him as a flexible resource, to be utilized as they find meaningful. Statements which are contained in the Q-sort (see Appendix, cells 1, 2, 3, for examples), in designs I and II, and which contain a permissive component, are worded so that a person inclined to implement the above in his teaching work will find an appeal in the statements. Operationally, this means that for the permissively inclined person in the act of Q-sorting, the statements with permissive aspects will gain greater significance than will the authoritarian statements.

Guiding Concepts Relating to Educational Objectives

Academic objectives. Academic objectives relate to intellectual development, knowledge in many fields, discernment of quantitative relationships, abilities in communications, and intellectual achievement (55:6-7).

Social objectives. Social objectives relate to civic responsibilities, the objective being that each person will become a loyal, informed, participating citizen in the community, as well as in the school. Human relations are an important aspect of social objectives, in which each person may learn to live and work harmoniously with others (55:8-9, 16-17).

Vocational objectives. Vocational objectives include consideration of economic competency, in which each person will become successful in a vocation and well informed as a consumer (55:10-11).

Guiding Concepts Relating to Change in Attitude

While a combination of attributes bearing on philosophy and operations might seem to be an obvious matter in theory, the actual authoring and validation of statements to be used in the Q-sort design is difficult. The following guiding concepts pertain to the most important combinations in design II, and are presented to show how a combination of attributes is considered.

Permissive, with emphasis on learning and teaching. This correlate corresponds to descriptive statements found in cell "af" in design II, exhibited in Figure 4 (see Appendix, cell 3, for examples), and refers to a person who emphasizes the development of the individual, in direction of his needs and interests. The representative of this correlate is tolerant of excesses in the classroom; he gives value to recognition that pupils get from their peers. He conducts class in a permissive and somewhat unstructured manner. He stimulates attitudes of self-involvement and query; he promotes interaction of the learning participants, minimizing the evaluative atmosphere.

Authoritarian, with emphasis on learning and teaching. This correlate corresponds to descriptive statements found in cell "cf" in design II, Figure 4 (see Appendix, cell 6, for examples), and refers to a person who indicates a conviction that teachers are for guiding the young, and who stresses conformance to patterns of social and academic behavior. He believes learning is largely a matter of teacher's ability to direct or inculcate. He takes forceful action to maintain an academic climate. He emphasizes the core of curricular fundamentals systematically, such as the 3R's, which he presents with authority and conviction. As a teacher he is a coordinating and directing agency for learning.

The explanation of the operational effect of statements on experimental persons in the act of Q-sorting, as related in the guiding concepts of the authoritarian and permissivist uncorrelated with learning and teaching, also apply to the above two guiding concepts. Theoretically, in Q-sorting, the statements which pertain to the above two concepts will have an appeal to those persons who are inclined to implement one or the other concept, and the type of statement in favor will gain correspondingly higher significance in Q-sorting than will other statements.

Recapitulation

Synthesis

This chapter has synthesized the main theoretical ideas of the study into a workable form for creating Q-sort designs appropriate for testing of hypotheses. Certain methodological matters were mentioned which are to be considered further in some detail. The central problem at this point concerns the development of suitable theory, and its representation in Q-sort instruments. Two aspects of the problem are considered in the statement of hypotheses in the first chapter: (1) that concerned with the status of an attitude, and (2) that concerned with attitudinal change. In the hypotheses relating to status of an attitude, it is affirmed that Q-methodology can identify its nature. In the hypotheses involving assessment of attitudinal change it is affirmed that Q-methodology can detect and assess change with some sensitivity, and can identify the direction in which the change was manifested. One Q-sort instrument could conceivably serve both purposes, but it would be more desirable to have two instruments, one designed to detect change, the other to identify predilections for school objectives, and both providing a parallel assessment in matters of philosophy.

All of the material reviewed in the foregoing sections points with some precision to the aspects of educational philosophy that should characterize the Q-sort designs. While nominal levels of authoritarian and permissive attitudes are used as labels, it is necessary to give richness to the guiding concepts in other ways. There are no definitions as such, in terms of which something can be determined to be right or wrong, or as conforming or not conforming with a qualitative criterion. Rather, the intent was to ascertain whether they truly represent some sociological realism.

The status of an attitudinal condition, when reduced to guiding concepts, was related to such school objectives as are found in the statement given in Point of View, published by the Los Angeles City Schools (55). These concepts are, in general, a parallel to Thorndike's well-known classification of intelligence into three kinds: mechanical, social, and abstract--divisions which might easily be interpreted and paraphrased as the vocational, social, and academic aspects of school objectives. Thorndike thought that each kind of intelligence was manifested by the quality of response which a person might make to stimuli stemming from any of these three areas. In the abstract design of a Q-sort, the effect which subsumes these objectives is called the effect of school operations. It is of interest to ascertain what student-teachers consider to be the relative importance of these objectives.

The attitudinal change condition is not a difficult aspect to specify in operational terms. It does not seem probable that a person would greatly alter his philosophical commitment as a result of one semester of student teaching. It is more conceivable that a change will occur in his appreciation of teaching skills, which might be represented in a deepening of involvement in learning and teaching theory, and as a result of gaining greater "apperception" of the teaching function. To illustrate the point more concretely, one may consider, first, the ordinary citizen who may not have a detailed knowledge of the school and its objectives, but will have a good appreciation of cultural matters within his society. Then, the parent will have certain expectations of the school for his children, even though he may be without detailed knowledge of teaching techniques. Finally, a depth of involvement of the novice in the teaching act will cause him to develop greater appreciation and apperception into matters relating to teaching and learning. In the abstract design of a Q-sort, the effect which subsumes these hierarchical levels is called the effect of school operations. The expectation from application of the design in Q-sort operations is that, with a properly authored set of statements, the student-teachers will show a deepening of appreciation in the hierarchy, a change which will be revealed in statistical ways by Q-methodology.

Bereiter (4) makes the observation that for a test to reveal differential changes, it must measure characteristics that are subject to differential change; this design must also involve a sensitivity to the selected aspects of the domain of consideration. Q-sort design I is expected to be relatively insensitive to change, whereas Q-sort design II was developed to be sensitive to the changes in teaching behavior.

Q-Sort Construction

The population of statements which are selected for a Q-sort design are assembled, derived, and devised to fill out the designs theoretically considered. Editorial effort is made to secure the meaning desired for each cell of a Q-sort design, with the use of guiding concepts to bring about a kind of homogeneity within effects and levels. A panel of judges is often used to edit statements, but certain operational difficulties must be foreseen; for example, in all probability, a panel of educationally sophisticated judges will not attach the same meaning to statements as will the type of novice experimental persons who read them in Q-sorting. The concern is also with validity in a Q-sort statement; and the kind of validity desired at the point of statement construction is that a statement must be capable of acting as a semantic stimulus with high informational content to the prospective reader. Validation of a Q-sort can be thus considered to be partly a matter of "semantic validation." This concept applied to a statement in a Q-sort means that the statement should convey an accurate meaning--i.e., it must be semantically clear and relevant to the part of the Q-sort design to which it is assigned.

Information theory will offer some solution to the problem of validating Q-sort statements. The procedures of Attneave (2) and Garner (30) offer a system of stimuli identification which, as applied in this study, means the process for reducing the uncertainty in the semantic performance of a Q-sort instrument. It may also mean a building up of confidence in an instrument to convey relevant information when it is applied to a situation of psychological interest. Briefly, information theory considers a subject's performance in an act of stimulus identification as a function of the uncertainty of the set of stimuli. Transmitted information is a matter of computing joint probability distributions of input and output signals. If the input and output are perfectly correlated, then the information transmission is the same as the output. The unit of measure in information theory is the "bit," which represents a measure of information transmitted from stimuli to response.

Block (6:84) suggests that the criterion to be used to guide the Q-sorter in his operations be informational in nature; that is, he uses the concept of information as it is employed in information theory, as described above.

CHAPTER III

RESEARCH PROCEDURES

This chapter presents general descriptions of the various procedures used in conducting the investigation, including (1) a statement of the sequence of preparatory procedures essential for conduct for such a study, and (2) an explanation of the necessity for certain of the mathematical models and procedures needed for the examining of the theory and propositions up for testing, and (3) a statement of the time sequence in testing together with a brief description of the experimental groups.

The criterion for description of a procedure is that it shall provide sufficient detail so that another researcher would be able to reproduce the study or to do one of similar type. While the central interest in the study is indicated in Figures 5 and 6, illustrating the sequence of events and nature of the study, certain essential preparatory procedures are necessary, such as (1) generating a theory for the Q-sort design, (2) assembling statements, (3) validating statements, (4) conducting pilot studies, and (5) preparing utility computer programs. The planning and preparation for the study, thus, is probably the most extensive aspect of the procedure, since many of the details do not follow a prescribed order of accomplishment, and many occurred concurrently.

The following steps in preparatory procedure were considered essential:

1. Generation of a theory for the Q-sort design. Certain aspects of generation of a theory for the Q-sort design have been developed in the previous chapters. In a general sense, the theory surrounds an initial problem, which is the specific motivation for the study. In Q-methodology the construction of instruments, or Q-sort statements (referred to here as Q-sorts), is the most detailed aspect of the preparatory procedure; it follows the development of a suitable theory that is brought to bear on hypotheses.

2. Construction of Q-sorts. The assembly of statements for filling out of the design of the Q-sort

should represent the accumulated apperception of the professional educator, brought to bear in natural and realistic terms on each phase of the predetermined factorial design. The usual precautions for construction of statements apply, such as Edward's informal criteria for attitude statements (25:13). Edwards (24) also presents material that aids in the preparation of statements, thus minimizing the effect of what he calls the social desirability factor.

3. Validation of statements. While the statements may often appear to convey meaning to a professional, they may not have the same meaning for the experimental person. Statements that are assembled as candidates for the Q-sort may also be poorly conceived, and may convey faulty or conflicting concepts. Semantic validation is considered to be a problem of major importance in developing new instruments, such as Q-sorts. This type of validation is presented in the next chapter which illustrates the application and utility of information theory (2). Computer programming was used to reduce extensive hand computations that would be required, to a simple matter of assembly of decks of printed and pre-coded computer cards.

As with many of the computer applications reported in this study, the procedures evolved from laborious hand procedures which are impracticable in terms of volume data processing. Hand computational forms are useful to demonstrate the mathematical relations involved, and the computer mathematics written in FORTRAN language are generally based on those forms. A few such forms are given in the next chapter.

The success that attended the application of information theory to semantic validation of Q-sorts led to the discovery that the validation process was actually a good reading comprehension test in its own right. Scores are obtained, called T-scores, which reflect on the ability of the experimental person to transmit information. Experimentation with these T-scores, which are actually bits of information transmitted by the experimental person after having been exposed to a semantic stimuli, has indicated a significant correlation with other types of cognitive measures, and are generally normally distributed. The usefulness of the T-score as a cognitive measure of reading comprehension in educational matters is considered to be of considerable importance. In Figure 6 there is indicated a scheduling of groups to take the reading test as the first event. The reporting of the results of this reading test, together with the discussion of the relationship of this measure as a cognitive matter, with other measures as affective matters, are discussed in the next chapter.

4. Conduct of testing. Figures 5 and 6 in Chapter I, and repeated here on the following pages, illustrate the sequence of events in the Q-sorting, testing for reading comprehension by information theory measure, and the general nature of the study timewise. These figures, in paradigm form, indicate generally a pretest-posttest type of examination of experimental groups of student-teachers, beginning teachers, and master teachers. Each homogeneous group was tested during one semester of teaching experience. Groups listed in Figure 5, that is, groups X_1, X_2, X_3, X_4 and X_5, were tested during the spring of 1963 with a first edition of Q-sort designs I and II. Groups listed in Figure 6, that is, groups X_6, X_7 and X_8, were tested during the spring of 1964 with revised forms of Q-sort designs I and II. The revised forms are essentially parallel forms, and written to be shorter in statement length, and with what was hoped to be sharper and more significant semantics.

The validation process, which is not listed in the sequence of testing events in Figures 5 and 6, was considered to be a matter of preparation. Validation required considerable preliminary testing, both before the formal 1963 testing sequence in Figure 5 and before the formal 1964 testing sequence in Figure 6. As many as 100 persons, called validators, and drawn from miscellaneous available groups of student-teachers in their second semester of student teaching, and not involved in the formal testing program. These persons served to validate the testing instruments in their preliminary form.

The paradigms displayed in Figures 5 and 6 are an adaption of the types of designs of experiments used by such researchers as Campbell and Stanley (11) and Travers (85:352). The comparison groups in Figure 5 include three groups of student-teachers and beginning teachers, with two groups of master teachers, identified as follows:

1. X_1 group, consisting of 27 elementary school student teachers in their first semester of student teaching, and enrolled in the regular

program of teacher education at the University of Southern California.

2. X_2 group, consisting of 39 secondary school student teachers in their first semester of student teaching, in the regular program of teacher education at the University of Southern California.

3. X_3 group, consisting of 25 master teachers in elementary schools. These teachers had one or more of the student teachers of group X_1 under their supervision.

4. X_4 group, consisting of 43 secondary school master teachers. These teachers had one or more of the student teachers in group X_2 under their supervision.

5. X_5 group, consisting of 40 beginning teachers, enrolled in the University of Southern California teacher education project, teaching on a provisional credential, while concurrently taking course work at the university leading to qualification for a general elementary teaching credential.

The comparison groups in Figure 6 include three groups identified as follows:

1. X_6 group, consisting of 62 undergraduates taking their first course in education at the University of Southern California.

2. X_7 group, consisting of 55 secondary school student teachers in their first semester of student teaching, and similar to the group X_2, but different individuals.

3. X_8 group, consisting of 60 beginning teachers, similar to the X_5 group, but different individuals.

The number of persons comprising each experimental group consisted of all the persons that constituted the groups by reasons of the school organization, and not by reason of any individual selection in this study. Every effort was made to gain an array from each of the individuals in a group according to the planned sequence of the study. It was inevitable that there would be failures to gain a complete set of performances. In general the participation was near the maximum, and in the tabulation of data there is an indication of the actual numbers of persons that participated in each group performance.

The above described groups of experimental persons were selected for participation by reason of their natural fitting into what Stephenson calls a variate design (76: 133); that is, each group was relatively homogeneous, and each group represented a different status in the progress of its members toward attainment of a teaching credential, except for master teachers. It was not the intent of this study to modify in any way the preparation of the experimental groups, other than to conduct testing of all persons available in each group in a formal manner. The repeated administrations of design II provided evidence of change of attitude. The single administration of design I was planned to provide evidence of attitudes toward objectives of education, as well as to confirm the evidence relating to education philosophy in design II.

The evidence gained from testing of the two groups of master teachers, X_3 and X_4, enabled comparison to be made between master teachers and their corresponding student teachers.

The members of all groups contributed to the development of factor arrays, as discussed in a later section of this chapter.

In order to insure a common level of attention of experimental persons to the Q-sort designs, only one set of instructions was given, presented in both written and verbal manner to motivate the sorting behavior. The essence of the instructions was as follows:

> The pack of statements (in the Q-sort) contains descriptions of matters pertaining to education. You are invited to arrange the statements in a special kind of rank order. Basically the rank order is an order of importance, or significance, to you in your role as a teacher in the classroon situation in which you are now serving.

Other aspects of the instructions given to the experimental persons were of a mechanical nature, e.g., how to get started, how to lay out pile cards, and how to reassemble the pack of statements comprising the Q-sort so that it would be in acceptable form for the computer.

In general, the testing of groups listed in Figure 6, a Q-sorting on design II-1, was completed in February 1963; design I was completed during the latter part of April 1963; and design II-2 during the months of May and June 1963. Testing of groups listed in Figure 6 generally paralleled that of the testing in Figure 5 in 1964. This Q-sorting conformed in the main with the planned sequence of testing. The student teacher groups and the beginning teacher group (X_1, X_2 and X_5 in 1963; X_6, X_7 and X_8 in 1964) were tested as assembled groups, and Q-sorting conducted in rooms having tables and adequate space for laying out cards. This is a rather important logistic consideration, as the size of the conventional university classroom chair is inadequate for Q-sorting. Meetings were held with the master teachers (groups X_3 and X_4) in several subgroups in their schools, for the giving of instructions. These participants were permitted to take the instruments home and to carry out the Q-sorting there. The testing conditions for the master teachers were dictated by the conditions attending their participation, ranging from the ready availability of the teachers in a school as a group, to the necessity for meeting with individuals during an office hour. Efforts were made by letters from the director of teacher education at the University of Southern California, and by telephone calls from the chairman of the committee on research studies in the Los Angeles City School system, to obtain the maximum cooperation possible from school principals and teachers in the study. The time and effort involved in person-to-person contacts required for distributing and collecting Q-sorting material to more than 50 master teachers in 17 different schools constituted the greatest physical expenditure in the study.

About 100 Q-sort instruments of each design were made so as to be able to meet the schedule of Q-sorting. The Q-sort statements were prepared on computer data cards, key-punched with coded data, so that any array could be processed directly in the computer. The computer output consisted of a printed distribution matrix, a score matrix, and an analysis of variance, as basic information constituting historical record of a person. Serial numbers were assigned to all persons, which appeared as identifying information on computer output. Score matrices and column scores of matrices were also key-punched by computer, and these data served as the basic raw data for further computations. Printed data served as reference material for classifying persons into types, preparatory to computation of factor arrays from information by factor analysis.

Variations in the computer program TABLE permitted the production of duplicate copies of output, and punched output of score matrices. Correlations of arrays with factors were also provided as another variation of the program. Variations in the types of output permitted the variations in the utilization of the output, whether for "action research" in a particular class, for classification of results, or for accumulation of raw data for further use. Historical records in this study are then seen to consist of printed output and punched cards, each type of record serving a particular purpose.

CHAPTER IV

STATISTICAL METHODS

This chapter presents statistical methods which are characteristic of Q-methodology, together with some variations of standard statistical analysis which were applicable to derivative data obtained in this study. This chapter is designed to provide a detailed confirmation of methodological aspects of the research hypotheses, so as to lend credence to the general proposition that a complete system of assessment of affective behaviors in the field of education can be devised that utilizes available computer techniques of data processing. In support of this general proposition the statistics of the Q-sort are applied to the individual case, and extended to the group. In each case certain formats are displayed to illustrate mathematical relationships which, while usually quite simple to compute by hand, are laborious when done in volume.

Validation is a problem of major importance in developing new instruments, such as Q-sorts. A type of validation called semantic validation is presented which illustrates aspects of application of information theory (2). Again, in the process of validation, computer programming was used which reduced hand computation to a matter of preparation of input data in suitable form.

The computation of factor arrays, as an empirical matter, utilizing the results of factor analysis of Q-sort information, is probably the most important development reported in this chapter. The factor arrays provide the objective statement of the various teaching types, by means of which individual and group performances were correlated.

Computer Programs

Preparation of computer programs. The most important computational problem in volume analysis of Q-sorts is the suitable processing of raw data and its immediate derivatives. Library programs, such as are available for use at the Western Data Processing Center, University of California at Los Angeles (86), are extremely useful. Library programs have a restrictive feature when applied to a specialized field of investigation, such as Q-methodology, in that most of the statistical formats apply to models patterned after the R-methodology. In a certain sense an investigator is practically forced into learning a second algebra, that of FORTRAN, in order to design utility programs. This is true if only to be able to utilize the highly developed library programs that are available, simply by furnishing properly organized input data. The degree of skill one attains in the second algebra in a large measure determines the degree of his intelligent use of the power of the computer. Q-methodology, having considerable variation in its postulational foundations from R-methodology, requires certain modifications of raw data input to properly use library programs. Many of the computational problems in Q-methodology are rather laborious, in which the computations are of the straightforward form-filling-out nature. To obviate the necessity for hand computations of this nature the Q-sort instruments were printed on computer data cards having coded symbols which can be processed by a suitable computer program. The concept of obviating hand processing entirely naturally extended to having the computer punch certain varieties of output in cards for the purposes of providing input for derivative and summarizing programs. For example, it would be laborious to prepare data cards for a factor analysis involving a matrix of 50 x 50 correlation coefficients if the cards were hand punched. The same matter accomplished by suitable computer program directly from raw score matrices is simple and accurate. This example illustrates the utility of the program bearing the abbreviated title CORAM in Figure 8a illustrating the computer programs developed for this study. The greatest time-saving program TABLE, which accepts sorted decks of cards comprising individual Q-sorts, and produces for each a distribution matrix, a score matrix, an analysis of variance, and other computations, if desired, such as correlations with factors and test for homogeneity of variance. This program makes it possible for the teacher to obtain class results with no hand computations, and for any reasonable number of performances, that is, limited only by the number of Q-sort decks available and the convenience of sorting facilities. Rooms with tables are usually the best for conducting Q-sorting, so that experimental persons can lay out cards. The program VALID has the same convenience as TABLE when a transmitting score (T-score) is desired from a class of experimental persons, as a measure of cognitive ability in reading comprehension in matters pertaining to education, or for validating newly designed instruments. Examples of output of TABLE, VALID, and other programs are given in the following pages of this chapter.

The computer programs listed in Figures 8a and 8b are not general programs; that is, they are specific to the particular Q-sort design that has been described in this study. For example, the analysis of variance program titled ANVAR is specific for a 2 x 3 factorial design, and program TABLE is specific for a 54-statement Q-sort distributed into nine categories with a specified frequency in each category. This does not mean the programs cannot be easily changed to accommodate to any other format that may be desired. The programs do lend themselves as a basis for modification in various ways, but generally a knowledge of FORTRAN would be necessary to make changes.

The FORTRAN statement of program TABLE is listed in the Appendix, with a brief description of its method of utilization. The listing of other programs would make this report of inordinate length.

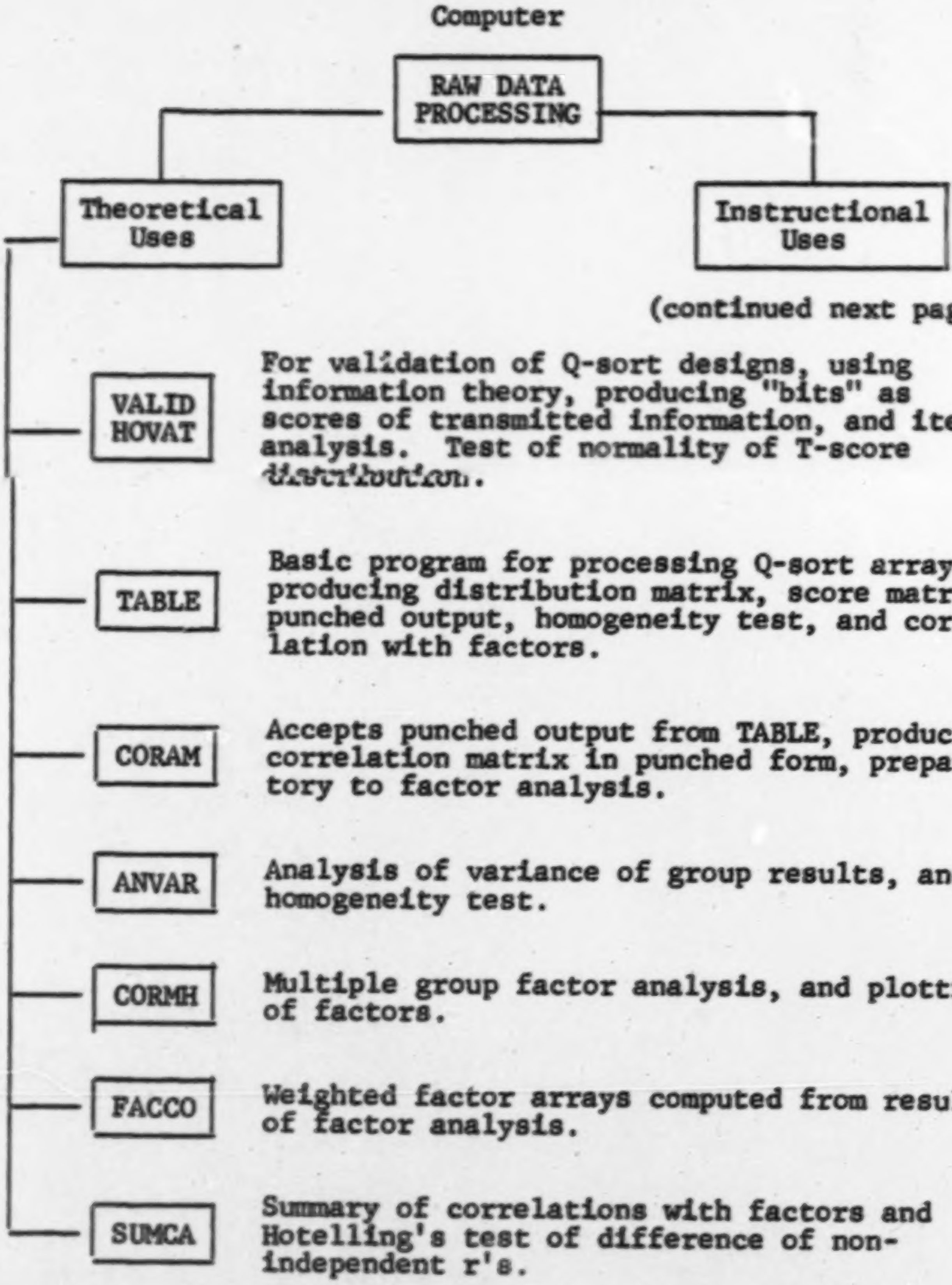
Validation

General Procedure

Validation, in the manner applied in this study, is construed as the process of reducing the semantic uncertainty of a Q-sort. The process may also be considered as a method for determining the level of confidence in the instrument considered as a whole for conveying relevant information pertaining to the theoretical design when it is applied in a situation of psychological interest. The preliminary steps involved in validation include: (1) a review of the situation of psychological interest, or

FIGURE 8a

ILLUSTRATING RELATIONS OF FORTRAN UTILITY COMPUTER PROGRAMS AS APPLIED TO Q-METHODOLOGY



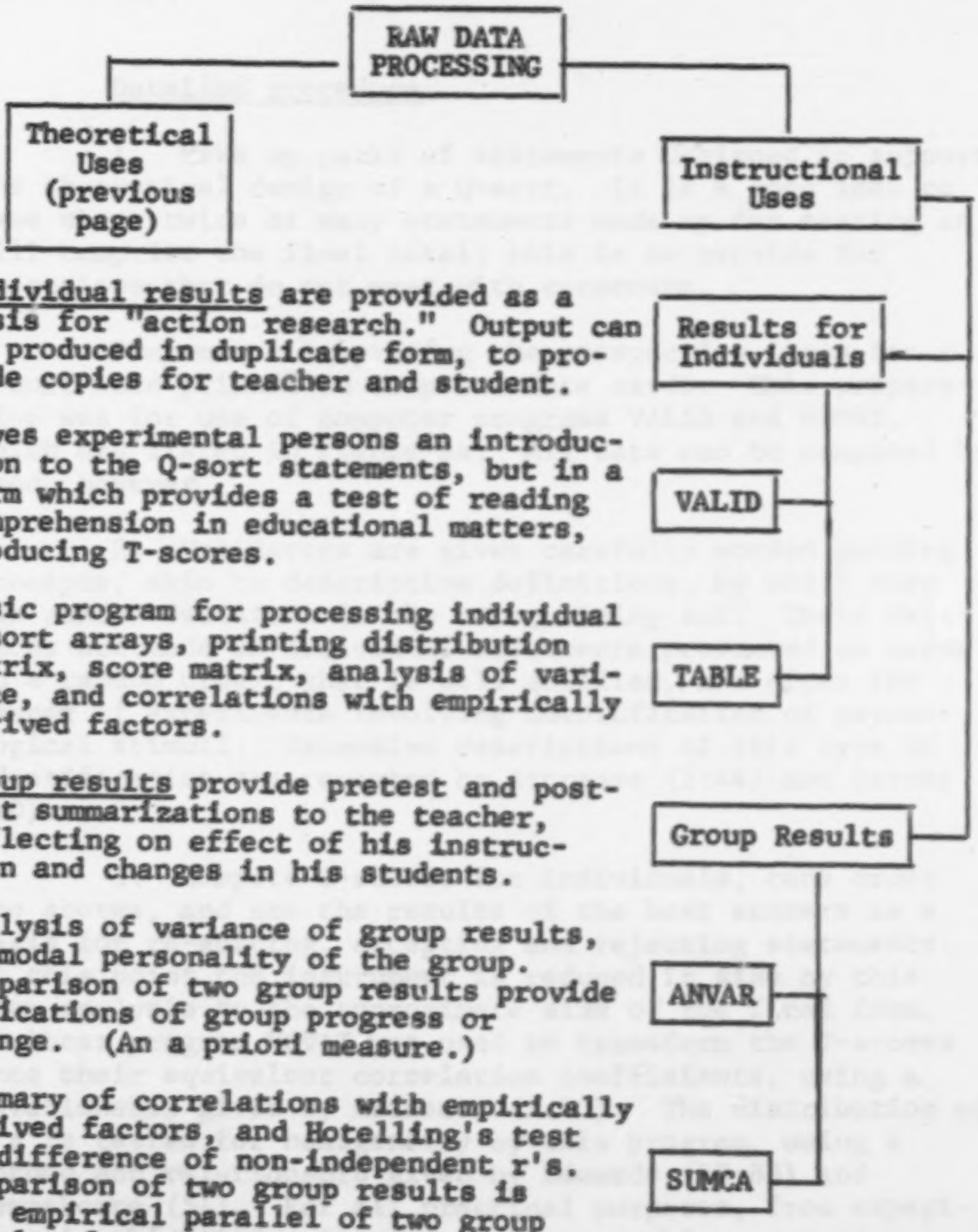
(continued next page)

VALID HOVAT	For validation of Q-sort designs, using information theory, producing "bits" as scores of transmitted information, and item analysis. Test of normality of T-score distribution.
TABLE	Basic program for processing Q-sort arrays, producing distribution matrix, score matrix, punched output, homogeneity test, and correlation with factors.
CORAM	Accepts punched output from TABLE, producing correlation matrix in punched form, preparatory to factor analysis.
ANVAR	Analysis of variance of group results, and homogeneity test.
CORMH	Multiple group factor analysis, and plotting of factors.
FACCO	Weighted factor arrays computed from results of factor analysis.
SUMCA	Summary of correlations with factors and Hotelling's test of difference of non-independent r's.

FIGURE 8b

ILLUSTRATING RELATIONS OF FORTRAN UTILITY COMPUTER PROGRAMS AS APPLIED TO Q-METHODOLOGY

Computer


RAW DATA PROCESSING
Theoretical Uses (previous page)
Instructional Uses
Results for Individuals
VALID
TABLE
Group Results
ANVAR
SUMCA

Individual results are provided as a basis for "action research." Output can be produced in duplicate form, to provide copies for teacher and student.

Gives experimental persons an introduction to the Q-sort statements, but in a form which provides a test of reading comprehension in educational matters, producing T-scores.

Basic program for processing individual Q-sort arrays, printing distribution matrix, score matrix, analysis of variance, and correlations with empirically derived factors.

Group results provide pretest and posttest summarizations to the teacher, reflecting on effect of his instruction and changes in his students.

Analysis of variance of group results, or modal personality of the group. Comparison of two group results provide indications of group progress or change. (An a priori measure.)

Summary of correlations with empirically derived factors, and Hotelling's test of difference of non-independent r's. Comparison of two group results is the empirical parallel of two group results from ANVAR.

problem area; (2) statement of a representative theory to account for the situation; (3) the making up of a factorial design with which to subject the theory to test; (4) the assembly of statements with which to support the theory in the factorial design; and (5) semantic validation of the statements by uncertainty analysis, also known as information theory.

Detailed procedure.

1. Make up packs of statements designed to support the theoretical design of a Q-sort. It is a good idea to have about twice as many statements made up for testing as will comprise the final total; this is to provide for rejections that do not meet with consensus.

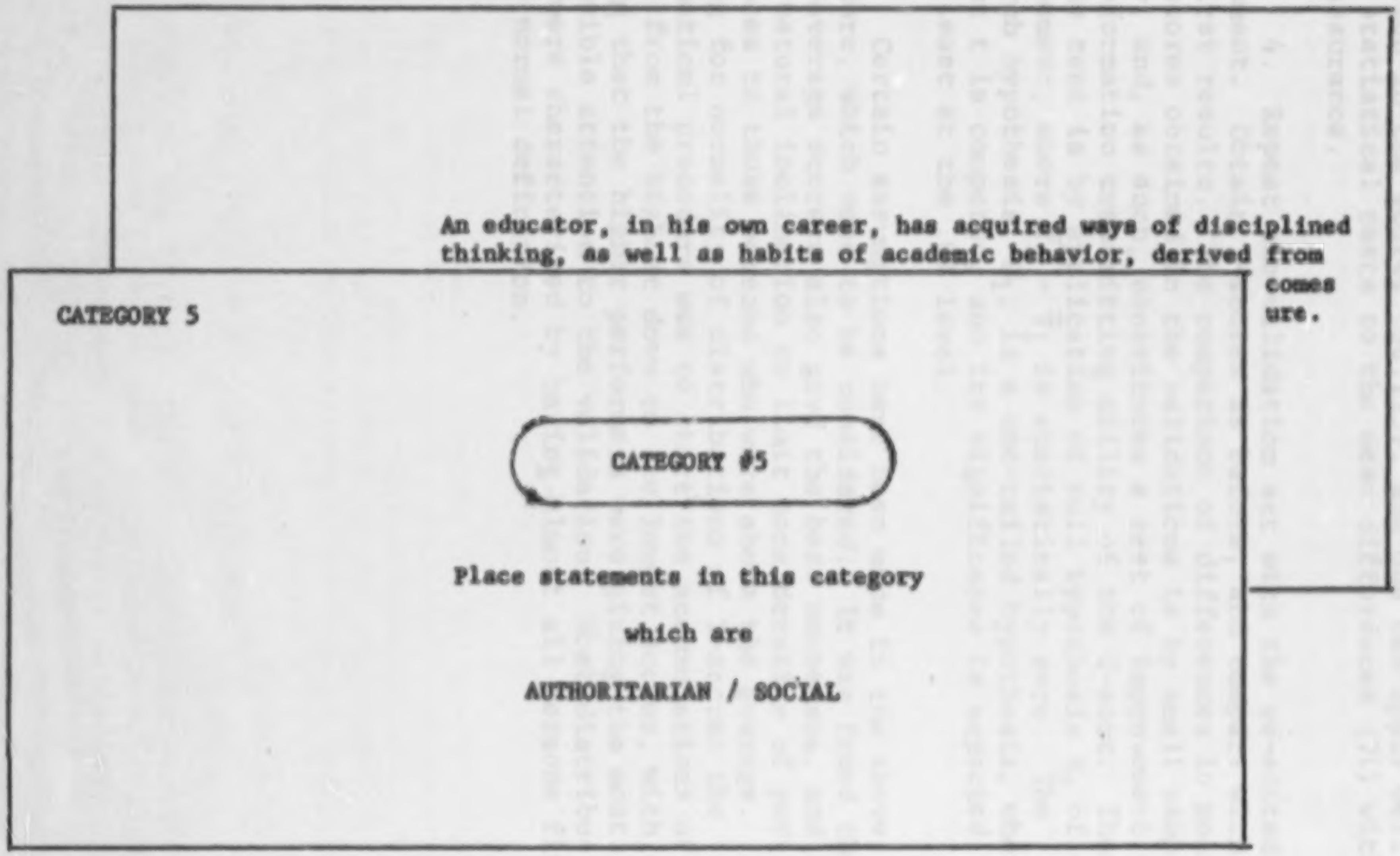
Statements comprising the prospective items for a Q-sort were printed on computer data cards. This preparation was for use of computer programs VALID and HOVAT, which are listed in Figure 8a. All data can be computed by hand, however.

2. Validators are given carefully worded guiding concepts, akin to descriptive definitions, by which they can render decisions in the categorizing act. Their decisions are made on individual statements presented on cards in a random order, that is well shuffled, and after the manner of experiments involving identification of psychological stimuli. Extensive descriptions of this type of identification are reported by Attneave (2:44) and Garner (30).

3. Compute T-scores for individuals, rank order the scores, and use the results of the best scorers as a basis for re-editing, accepting and rejecting statements. At this point the instrument is reduced in size by this item analysis to the approximate size of the final form. Computer program HOVAT was used to transform the T-scores into their equivalent correlation coefficients, using a relationship given by Attneave (2:95). The distribution of r's is tested for homogeneity by this program, using a method and relationship given by Edwards (23:83) and Kempthorne (51). For all practical purposes, from experience in this study, it appears that graphic means of determining the above matters serve quite well for hand computations. T-scores can be tested for normality by

FIGURE 9

ILLUSTRATING FORMAT OF INDIVIDUAL Q-SORT STATEMENT
WITH CATEGORY CARD FOR T-TEST OR VALIDATION



An educator, in his own career, has acquired ways of disciplined thinking, as well as habits of academic behavior, derived from

comes

ure.

CATEGORY 5

CATEGORY #5

Place statements in this category

which are

AUTHORITARIAN / SOCIAL

plotting on probability paper, and approximate means and standard deviations can be estimated from such a plot. If the distribution of T-scores plot in a straight line, it can be assumed there is evidence of a nearly normal distribution in the scores (86:125), and one can apply well known statistical tests to the mean differences (71) with some assurance.

4. Repeat the validation act with the re-edited instrument. Obtain T-scores as before, and compare with the first results. The comparison of differences in means of T-scores obtained in the validations is by small sample theory, and, as such, constitutes a test of improvement of the information transmitting ability of the Q-sort. That is, the test is by application of null hypothesis H_o of no improvement, where $\overline{T}_2 - \overline{T}_1$ is statistically zero. The research hypothesis, H_1, is a one-tailed hypothesis, where Student t is computed, and its significance is expected to be at least at the .01 level.

Certain assumptions have been made in the above procedure, which need to be considered. It was found that above-average scorers also gave the best consensus, and it was a natural inclination to limit consideration of performances to those persons who were above the average. In testing for normality of distributions of T-scores the mathematical procedure was to start the accumulations of scores from the highest down to the lowest scores, with the feeling that the higher performers were giving the most responsible attention to the validation. Most distributions were characterized by having almost all persons fit in the normal definition.

Computational aspects in validation. The computation of T scores, in terms of "bits" of information, follows a computational procedure that will be explained in this section. The mathematical model is similar to the three variable case discussed in some detail by Attneave (2:51). The T score, in bit measure, pertains to "transmitted information," which may also be considered to be a measure of relatedness, or shared information between stimulus and response. In the validation process information is presented to the experimental person as stimuli to be categorized. When the stimuli are presented equally often the amount of this information in bits is the logarithm, to the base 2, of the number of stimulus alternatives. It is necessary to present the stimuli in a random order, that is, the statements are well shuffled before response decisions are made. In the practical solution of the problem, the objective is to determine how much of the information is actually conveyed, or transmitted, to the subject, and how much is lost.

A basic formula for computing the transmitted information is:

$$T(y,z;x) = H(y,z) + H(x) - H(x,y,z)$$

The reduction of this formula to computable form involves calculation of the amount of information which the two variables y and z, considered in combination as if they were one, transmit to, or share with, a third variable, namely x. That is, $T(y,z;x)$ is the part of $H(x)$ which is shared with or accounted for by the other two variables.

In validation there is interest in the possibility of correlation between the response variables. The expression for $T(y,z;x)$ can be compared with another formula, $T(x;y;z)$, in which the latter refers to all the shared or non-unique information in the system. The formula for $T(x;y;z)$ is:

$$T(x;y;z) = H(x) + H(y) + H(z) - H(x,y,z)$$

By subtraction of the first of the two expressions for T that have been given from the last there results an evaluation of the correlation between the response variables, symbolized by $T(y;z)$. This value can be interpreted as the amount of information transmitted by one component of the response to the other.

Figures 10 and 11 illustrate the use of the mathematical model in computation of T scores. The following computational formulas that are used are given theoretical development in the study by Attneave (2), and are applied to illustrate computations in an actual case in validating design II, with $n = 108$.

$$H(x) = \log n - 1/n \Sigma n_i \log n_i$$

$$H(y) = \log n - 1/n \Sigma n_j \log n_j$$

$$H(z) = \log n - 1/n \Sigma n_k \log n_k$$

$$H(y,z) = \log n - 1/n \Sigma n_{jk} \log n_{jk}$$

$$H(x,y,z) = \log n - 1/n \Sigma n_{ijk} \log n_{ijk}$$

All sums are taken over the range of the indicated subscripts, and logarithms are taken to the base of two. H(x) being the stimulus variable, and having equal replication frequency in each cell of the Q-sort design, reduces to the logarithm of the number of cells in the design, which in the case of design I and II Q-sorts, is the logarithm of 6. All logarithms are to base of 2.

The expression for $T(y;z)$ as the measure of the amount of information that is shared between y and z is:

$$T(y;z) = H(y) + H(z) - H(y,z)$$

The validation computations that have been listed are laborious when done by hand. These are indicated for one example in Figures 10 and 11. A relatively simple computer program makes it possible to handle many individual performances and print out tally tables and T scores. In addition a computation is made from an interesting relationship between a value of T and r, derived by Attneave (2:96), which leads to an estimate of the r as a kind of index of reliability (32:351). The formula as given by Attneave reads as follows:

$$T(x;y) = \log \frac{1}{\sqrt{1 - r^2}}$$

The interest in the formula is that, given T, it is possible to compute the corresponding r. The relationship leads to the interpretation that T is the measure of the amount that is shared between x and y. By the same reasoning for the two variable case, and extended to the instant three variable case in principle, it is considered possible to calculate the amount of information any two variables, considered as a combination as if they were one, transmit to or share with a third. Thus from the last relationship a corresponding r for T(y,z;x) can be computed. For a distribution of r's a homogeneity test is possible by the method of Edwards (23:83). These theoretical matters are of importance when exploring the possibilities for other uses of T scores in the ways that have been suggested in this study.

A computer program titled VALID accepted packs of sorted cards, computed a tally table, T scores, and values for r. The design of the computer program reduced the computational formulas to the following notation:

T(y,z;x): TR1 = (SLFSUM - HLFSUM)/n + log H(x)

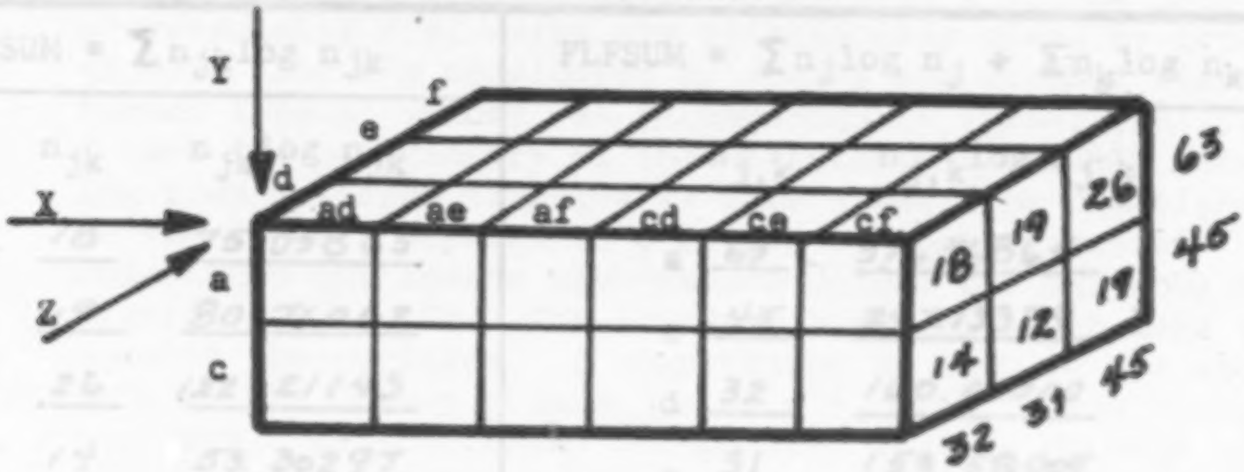
T(x,y,z): TR2 = (SLFSUM - FLFSUM)/n + log H(x) + log n

T(y;z): TR3 = TR2 - TR1

The results of applying these formulas to one case are illustrated in Figures 10 and 11. In the notation of Attneave the symbols for transmitted information are given with a circumflex over the T's and H's to indicate that the values are estimates, and obtained by use of empirical proportions, rather than representing true or a priori probabilities. The distinction is of theoretical importance, but for simplicity of presentation here, the circumflex is omitted. One important characteristic of the statistical measure that is used is that no assumptions are made about the metric, order, or quantitative relation between the underlying variables; the data are simply of classification.

FIGURE 10
MATHEMATICAL MODEL IN VALIDATION OF Q-SORTS
AND TO OBTAIN T SCORES

THREE DIMENSIONAL
STIMULUS-RESPONSE PARADIGM


Y
X
Z
f
e
d
a
c
ad
ae
af
cd
ce
cf
63
26
19
18
45
19
12
14
45
31
32

TALLY TABLE
WITH ILLUSTRATED DATA

		STIMULI CLASSIFICATION						
CELL		ad	ae	af	cd	ce	cf	SUMS
RESPONSE DECISIONS	ad	𝍸 𝍸 𝍷𝍷𝍷			𝍷𝍷𝍷	𝍷	𝍷	18
	ae	𝍷𝍷	𝍸 𝍸 𝍷𝍷𝍷	𝍷	𝍷	𝍷𝍷		19
	af	𝍷	𝍷𝍷	𝍸𝍸 𝍸𝍷		𝍷𝍷	𝍸	26
	cd	𝍷			𝍸 𝍷𝍷𝍷𝍷	𝍷𝍷𝍷𝍷		14
	ce	𝍷			𝍸	𝍸	𝍷	12
	cf		𝍷𝍷𝍷	𝍷		𝍷𝍷𝍷𝍷	𝍸 𝍸𝍷	19
SUMS		18	18	18	18	18	18	108

FIGURE 11
FORM FOR HAND COMPUTATION OF TRANSMITTED INFORMATION (T SCORES) WITH ILLUSTRATED DATA FOR ONE CASE

WORK SHEET FOR HAND COMPUTATION OF TRANSMITTED INFORMATIO

HLFSUM = $\sum n_{jk} \log n_{jk}$

	n_{jk}	$n_{jk} \log n_{jk}$
ad	18	75.05865
ae	19	80.71062
af	26	122.21143
cd	14	53.30297
ce	12	43.01955
cf	19	80.71062
SUM		455.01384

FLFSUM = $\sum n_j \log n_j + \sum n_k \log n_k$

	$n_{j,k}$	$n_{j,k} \log n_{j,k}$
a	63	376.56864
c	45	247.13339
d	32	160.00000
e	31	153.58009
f	45	247.13339
SUM		1184.41551

SLFSUM = $\sum n_{ijk} \log n_{ijk}$

Cell frequency data:

n	f	f x n log n
13	2	96.21144
3	2	9.50978
2	4	8.00000
16	1	64.00000
5	3	34.82892
9	1	28.52932
4	2	16.00000
11	1	38.05375
SUM		295.13321

SUMMARY OF COMPUTATIONS

	TR1 = T(x,y;z):	TR2 = T(x,y,z):
SLFSUM	295.13321	295.13321
HLFSUM -	455.01384	
FLFSUM -		1184.41551
sums	-159.88063	-889.28230
/n	-1.48037	-8.23409
H(x)	2.58496	2.58496
log n		6.75489
TR1, TR2	1.10459	1.40576
TR3 = TR2 - TR1:		.30117

Validation results of design II. Table 1 summarizes data taken from the validation efforts on design II Q-sort for both 1963 and 1964 editions of the instrument. The Student t-test is applied to the T-scores, using all data. Computer program HOVAT transforms T-scores into corresponding r's, using the relationship given by Attneave (2:95). The r's considered as scores are further transformed into z' values, as recommended by Fisher (26:197). A test for homogeneity of the distribution (23:83), starting from T-scores arranged in rank order from the highest to the lowest, results in a series of comparisons of calculated chi square with tabled values for chi square significant at .01. The standard error of z' is used to compute the variance. A computation is made of the estimate of the common population of r's, or $\bar{r}$, using homogeneous data. In most cases homogeneity extends through all of the data, confirming earlier tests of the data plotted on normal probability paper.

The basic interest in Table 1 is the fact there is an increase in validity of the instrument in its semantic character to be inferred, for both the 1963 and 1964 editions. This inference is gained from the statistically significant t-test that lends credence to the research hypothesis:

$$H_1 : (\bar{T}_2 - \bar{T}_1) > 0$$

That is, the increase in T-scores indicates a gain in the information being transmitted by the instrument.

The $\bar{r}$ is a measure of the reliability of the instrument used as a reading comprehension test in the validation procedure. The $\bar{r}$ cannot be claimed as a measure of reliability of the instrument in Q-sorting, as that operation and its reliability measure are largely functions of the experimental person. The increase in $\bar{r}$, from about .65 to about .76 in the separate validations, is a significant increase, just as the increase in T-scores is a significant increase.

TABLE 1
RESULTS OF VALIDATION AND EVENTS
T_6, T_7, AND T_8: DESIGN II

Item	Validation Events, Design II			
	1963 Edition		1964 Edition	
	II-1	II-2	II-1	II-2
Mean T, or $\overline{T}$	.867	1.269	.83	1.33
Mean r, or $\overline{r}$	.666	.760	.657	.773
Variance of T	.058	.100	.04	.14
$\overline{T}_2 - \overline{T}_1$		.402		.500
SE_{diff}		.084		.065
n: subjects	28	20	36	44
k: homogeneous performances	28	20	36	44
Student "t"		4.78*		7.63*

	Communicating Test Events, Design II		
	T_6: Pre-Student Teachers	T_7: Secondary Student Teachers	T_8: Beginning Teachers
Mean T, or $\overline{T}$	1.44	1.53	1.33
Mean r, or $\overline{r}$	.80	.81	.77
Variance of T	.16	.17	.14
n: subjects	62	58	44
k: homogeneous performances	57	57	44

*p < .01

T-Score as a Cognitive Measure

The following discussion presents some rationale for considering the T-score as a cognitive measure of some importance, particularly when used in conjunction with Q-sorting. The rationale stems from the expectation that communicating behaviors, as shown in a capability for semantic stimulus identification, provides certain necessary conditions for an individual to make an adequate performance in affective matters. The relations between cognitive and affective behaviors may also be considered analogously to the relations between a unit vector and a directed line segment, in vector algebra.

In order to explore the possibilities of the T-score as a cognitive measure, the 1964 series of Q-sorting events was prefaced by events listed as T_6, T_7, and T_8, which meant that the experimental groups bearing those subscript numbers participated in the validation procedure as a reading test. The procedure for conduct of the testing was exactly the same as for validation, except that the reasons given to the participants were to the effect that it was for familiarization with the content of the Q-sort, as well as for gaining a score. The obtained T-scores were processed by computer programs VALID and HOVAT, with a summary of results listed in Table 1.

Additional information obtained from events T_6, T_7, T_8 includes verification that the score data is substantially normally distributed, and that reliability of the instrument, when used as a reading test after the manner of R-methodology, is about .80. Further, the conclusion is made that research data of this type, which rest on small sample theory and t-test, substantially meet the requirements as outlined by Siegel (90:18-20).

Q-Sort Statistics

General Considerations

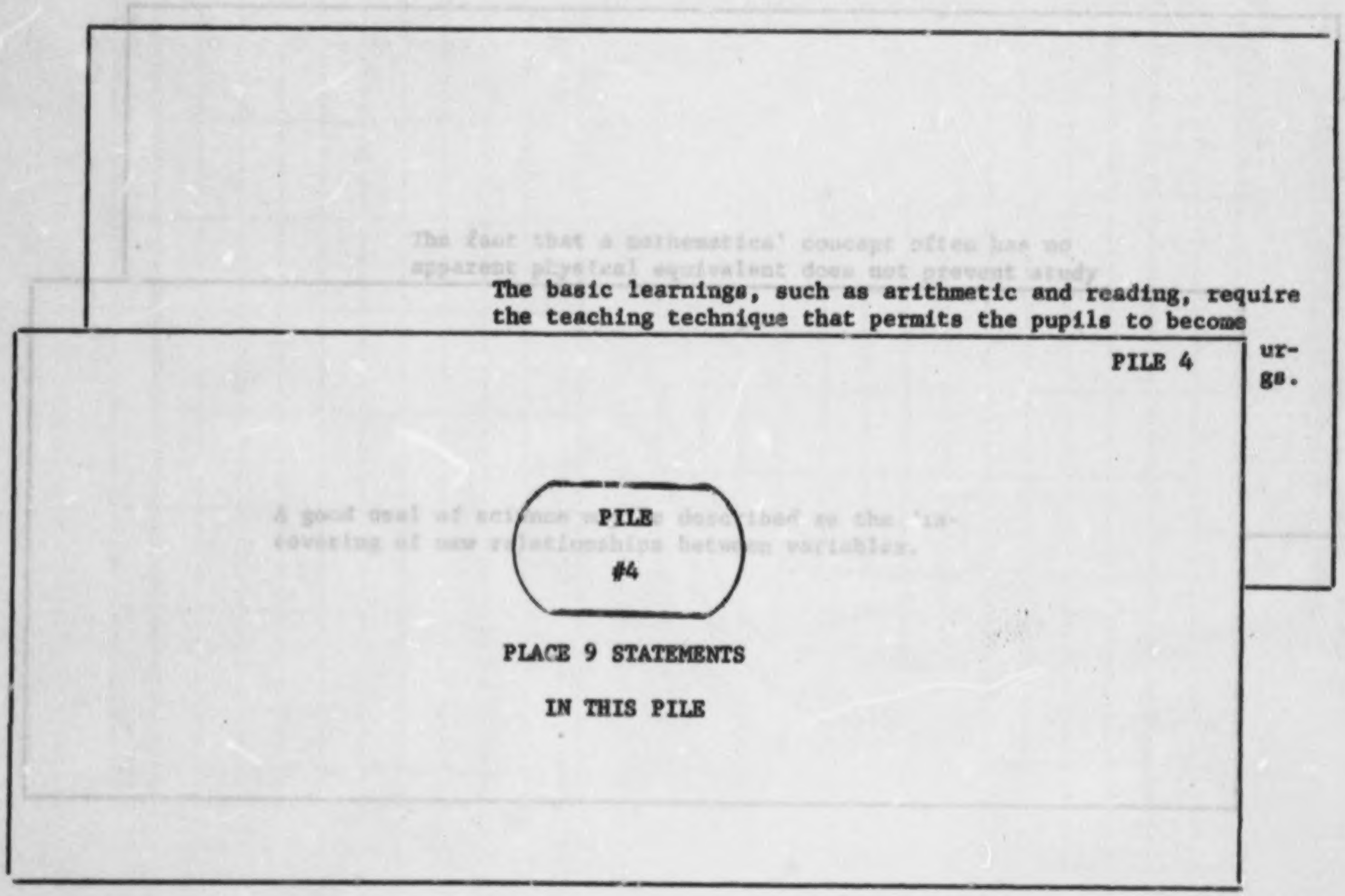
The conventional Q-sort instrument consists of statements, printed on cards, one statement to a card; the pack of statements comprises the basic stimuli and dependent variable in Q-methodology. Certain aspects of the theory of the Q-sort as a testing instrument have already been discussed in previous chapters. After some experience with hand computation of the statistics involved in Q-sorting, it was concluded that the methodology would hardly gain acceptance in the field of education with such laborious procedures. The same conclusion was reached after hand computations in the validation events. The clearing away of these objections by the use of statements reproduced on standard-size, square-cut, blank computer data cards, keypunched with coded data for use in computer programs designed for the analysis, probably does more than anything else to make Q-methodology a thoroughly practical matter in educational matters, both for research and for instruction.

Figures 12 and 13 illustrate the format of the Q-sort statement and a "pile card." Pile cards are place holders used to assist the sorter in obtaining the fixed, symmetrical type of distribution of statements in the Q-sort array. Pile cards serve as reference points in the continuum of significance that the sorter maintains, and serve to determine the frequency of statements at these points.

The scoring and distribution formats adopted for Q-sorts in this study are illustrated in Figure 14. The formats illustrated are useful for constructing hand computational forms, for recording a distribution of statements in terms of identifying marks, and for recording scores. From this figure it may be seen that a symmetrical, quasi-normal distribution of statements is made by the sorter, into nine piles or distribution points of the continuum. Scoring conforms in a manner similar to the stanine system (35:503), and gives the greatest value to statements to the left in the scoring continuum, and the least value to the right. In the sorting instructions the experimental persons are directed to place statements to which they give the most significance in piles on the left. Statements which are considered to be of least significance are placed to the right.

FIGURE 12

ILLUSTRATING FORMAT OF INDIVIDUAL Q-SORT STATEMENT WITH PILE CARD



The basic learnings, such as arithmetic and reading, require
the teaching technique that permits the pupils to become
ur-
gs.

PILE 4

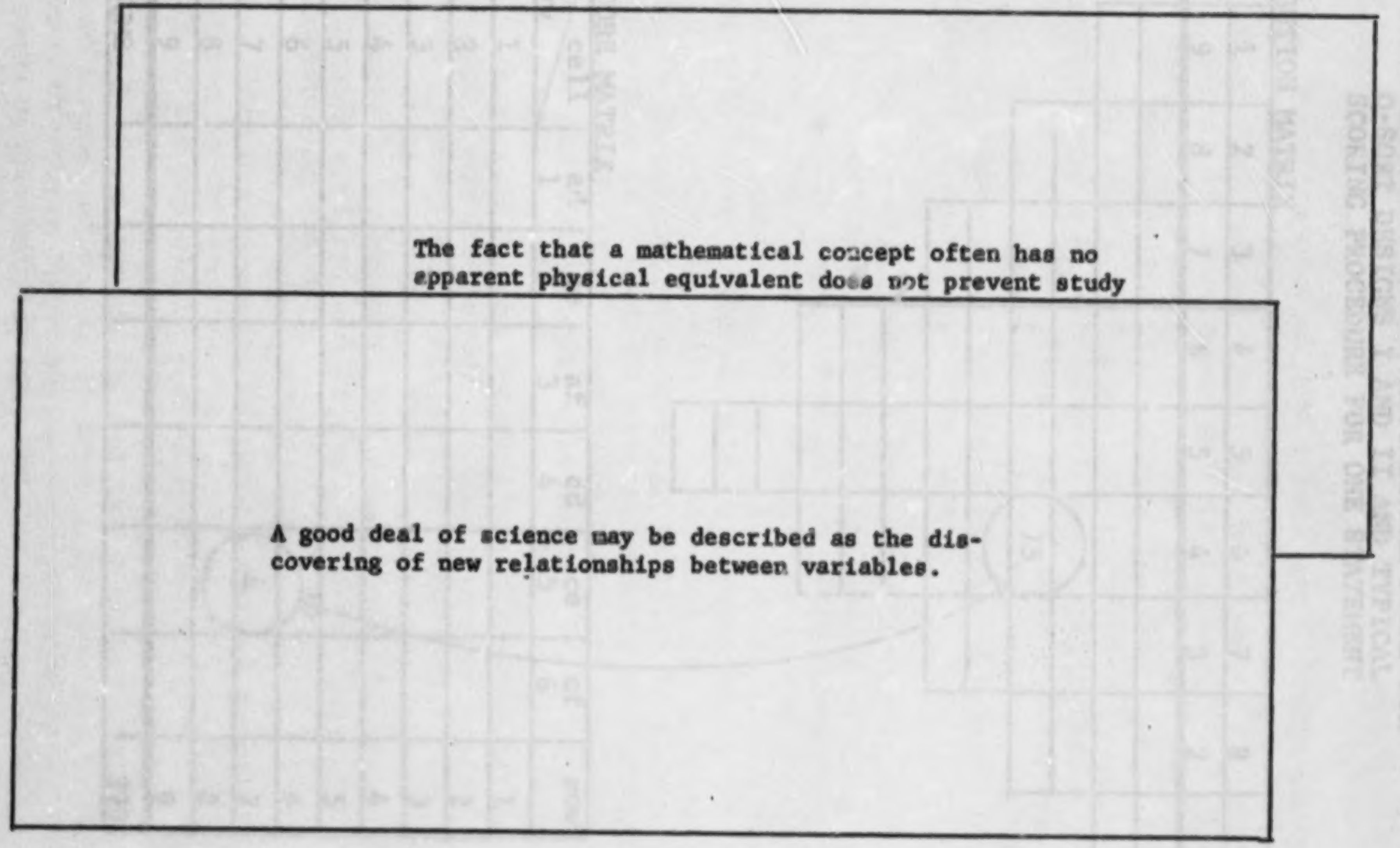
PILE
#4

PLACE 9 STATEMENTS

IN THIS PILE

FIGURE 13

ILLUSTRATING FORMAT OF INDIVIDUAL Q-SORT STATEMENTS ON COMPUTER DATA CARDS

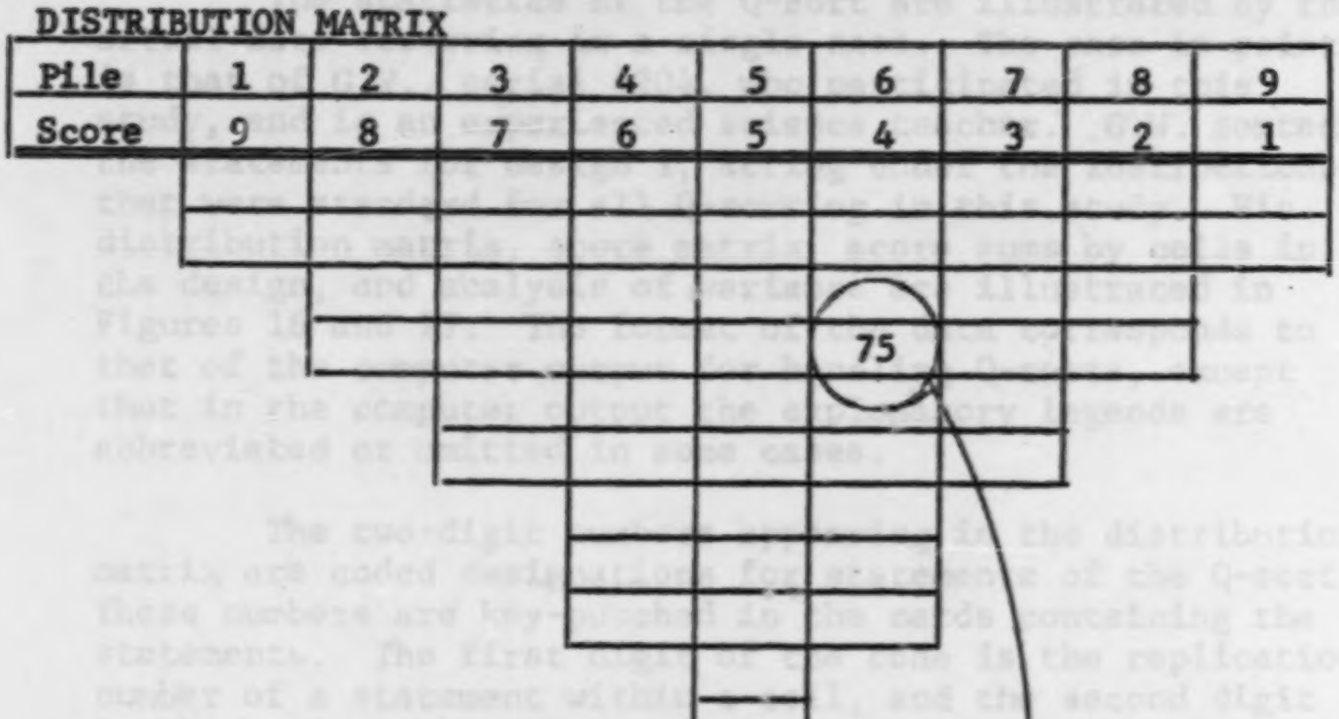


The fact that a mathematical concept often has no apparent physical equivalent does not prevent study

A good deal of science may be described as the discovering of new relationships between variables.

FIGURE 14

ILLUSTRATING HAND COMPUTATIONAL FORMS FOR Q-SORT DESIGNS I AND II AND TYPICAL SCORING PROCEDURE FOR ONE STATEMENT



DISTRIBUTION MATRIX

Pile	1	2	3	4	5	6	7	8	9
Score	9	8	7	6	5	4	3	2	1

75

SCORE MATRIX

cell / row	ad 1	ae 2	af 3	cd 4	ce 5	cf 6	row
1							1
2							2
3							3
4							4
5							5
6							6
7					4		7
8							8
9							9
SUMS							270

Q-Sort Statistics

Q-Sort Statistics Applied to a Single Case

The statistics of the Q-sort are illustrated by the actual data occurring in a single case. The case in point is that of G.W., serial 4204, who participated in this study, and is an experienced science teacher. G.W. sorted the statements for design I, acting under the instructions that were standard for all Q-sorting in this study. His distribution matrix, score matrix, score sums by cells in the design, and analysis of variance are illustrated in Figures 16 and 17. The format of the data corresponds to that of the computer output for handling Q-sorts, except that in the computer output the explanatory legends are abbreviated or omitted in some cases.

The two-digit numbers appearing in the distribution matrix are coded designations for statements of the Q-sort. These numbers are key-punched in the cards containing the statements. The first digit of the code is the replication number of a statement within a cell, and the second digit is the cell number. For example, statement 45 is the fourth replication in cell 5. A paradigm for illustrating the basic Q-sort design abstractly is given in Figure 15. This paradigm is filled out with statements within each of the illustrated cells, there being nine such replications in each of the six cells in this study.

Each cell in the Q-sort design, shown abstractly, represents a combination of two components of semantic content. For example, cell 5, designated "ce," is a combination of levels "c" and "e". Furthermore, each cell is represented by statements, not semantically identical but semantically similar, and in the last sense constitute replications of the cell.

When the experimental person assigns a statement to a position in the quasi-normal form, it derives a score by virtue of its position. For example, a score of 9 is given if a statement appears in the first column from the left, a score of 8 if it appears in the second column, and so on, down to a score of one if it appears in the last or ninth column. Of course the experimental person knows nothing of all these mechanical arrangements for the analysis; he knows only that he is to rank order statements in accordance with his predilections and the instructions given to him.

In a score matrix the entries are derived from the distribution of statements in the distribution matrix. The rows are replications within a cell, and the columns are the cells. The numbers in the body of the score matrix are derived from the distribution matrix; for example, statement 41 derives a score of 9 by virtue of its position; looking in row 4, column 1 of the score matrix, a score of 9 is recorded. Similarly for all other statements, scores are entered in the score matrix. At this point an estimate can be made of the experimental person's predilections, by arranging the column scores in such a way as to fill out the totals assigned to cells.

The abbreviated notations are interpreted as follows: PER is the permissive level of educational philosophy, and AUT is the authoritarian level. ACAD, SOC, and VOC stand for academic, social and vocational levels of educational operations, respectively. The totals in each cell, and the marginal totals represent the quantified extent of predilection of the experimental person for each cell and level. Clearly, in the example, the sum in the PER, or permissiveness level, is substantially greater than in the AUT, or authoritarian level. The sums in the levels of ACAD, SOC, and VOC (academic, social and vocational) do not appear to be substantially different. Analysis of variance will show which, if any, means are statistically different, provided the variance is homogeneous. The foregoing discussion may be applied to a typical case involving design I. In design II the notation is the same except for marginal notations in Figure 16, where abbreviations of ACAD, SOC, and VOC are replaced by GC, GS, and LT which identify levels of general culture, general school objectives, and learning and teaching theory, respectively.

FIGURE 15

A PARADIGM FOR ILLUSTRATING BASIC
Q-SORT DESIGN ABSTRACTLY

FACTOR A

	level a	level c		
	Cell 1/ad replications: 9	Cell 4/cd 9	18	level d
FACTOR B	Cell 2/ae 9	Cell 5/ce 9	18	level e
	Cell 3/af 9	Cell 6/cf 9	18	level f
	27	27	54: total statements	

FIGURE 16

ILLUSTRATION OF SINGLE CASE DISTRIBUTION MATRIX AND SCORE MATRIX OF A Q-SORT, DESIGN I

DISTRIBUTION MATRIX:

PILE:	1	2	3	4	5	6	7	8	9
SCORE:	9	8	7	6	5	4	3	2	1
	41	73	32	62	23	83	65	54	25
	53	43	35	42	51	63	22	44	45
		92	24	84	96	55	91	14	
		12	75	33	21	15	16	95	
			31	52	76	86	56		
			11	94	26	85	66		
				71	13	93			
				74	64	36			
				72	81	61			
					46				
					82				
					34				

SCORE MATRIX:

Row, and replication within a cell	Column, and cell number and designation						
	ad 1	ae 2	af 3	cd 4	ce 5	cf 6	
1	7	8	5	2	4	3	
2	5	3	5	7	1	5	
3	7	7	6	5	7	4	
4	9	6	8	2	1	5	
5	5	6	9	2	4	3	
6	4	6	4	5	3	3	
7	6	6	8	6	7	5	
8	5	5	4	6	4	4	
9	3	8	4	6	2	5	
Totals	51	55	53	41	33	37	TOTAL 270

FIGURE 17

A PARADIGM FOR ILLUSTRATING ARRANGEMENT OF COLUMN SUMS DERIVED FROM Q-SORT AND ANALYSIS OF VARIANCE

Factor B: Educational Operations		Factor A: Educational Philosophy Permissive PER	 Authoritarian AUT	Sums
Level d: Academics	AC	51	37	88
Level e: Social	SOC	55	33	88
Level f: Vocational	VOC	53	41	94
Sums		159	111	270

ANALYSIS OF VARIANCE:

VAR	SS	DF	MS	F ratios
TOTAL	202	53	9.42	
BETW	45.11	5	3.23	2.92*
WITH	154.89	48	42.67	
A/EFF	42.67	1	.22	13.22**
B/EFF	.44	2	2.00	.07
INTER	4.00	2		.62

*p < .05; **p < .01

Illustration of Q-Sort Statistics Applied to Groups

A composite array for a group is obtained in the following manner. The scores made by each individual on each statement of a Q-sort are needed. The result is a score matrix, similar to that for an individual, but in which the grand total is a multiple of 270. The composite scores for each statement are then rank ordered, and the statements fitted into the quasi-normal distribution. Thus the group has each individual contribute his influence with equal weighting, and the result is an array for the group as if the group were one person. The composite array is analyzed in the same manner as for a single person, which is now a kind of modal array. The correlations of the modal or composite array with empirically established factor arrays of teaching types afford a measure of the relation of the group or modal array to the types. An analysis of variance of the composite array affords a parallel type of assessment. Two composite arrays of a homogeneous group of persons are needed to assess changes in the group over a period of time. The nature of change can be assessed by analysis of differences occurring in the correlations with empirically established factor arrays, and by comparing analysis of variance results in the two performances. Both are described in following paragraphs.

An illustration of the foregoing reasoning and computation, in a particular case, is appropriate at this point. Figures 18 and 19 illustrate matters relating to the group known as elementary teachers, which was the fifth in the set of groups being tested in this study. Figure 18 illustrates the performance of the group on the first administration of design II, labeled II-1. Figure 19 illustrates the second administration of design II, which occurred later in the teaching semester, labeled II-2.

The comparison of the tables of correlation in Figure 20 is of basic interest, in that it shows the change within the group as a result of a teaching experience and other variables which may have entered to influence the result.

The labeling of factors in the correlation tables is as follows: PER, permissive; PER/LT, permissive and learning and teaching correlated; LT, learning and teaching without philosophic commitment; AUT, authoritarian; AUT/LT,

FIGURE 18

ILLUSTRATION OF COMPUTER OUTPUT FOR ANALYSIS FOR GROUP PERFORMANCE ON DESIGN II-1

```
ELEMENTARY TEACHERS, DESIGN II-1, MODAL ARRAY

   DISTRIBUTION MATRIX:
              63   23   43   36   76   84   22   91   92
              82   86   53   62   34   25   74   51   31
                   96   95   33   35   85   44   61
                   11   42   41   56   65   81   83
                        14   52   24   64   45
                        93   15   66   54   71
                             73   21   26
                             94   32   55
                             72   13   46
                                  12
                                  75
                                  16

   SCORE MATRIX:
                   8    5    5    7    6    5
                   5    3    8    5    4    4
                   1    5    6    5    5    6
                   6    7    7    3    3    4
                   2    6    7    4    4    5
                   2    6    9    4    4    5
                   3    6    6    3    5    5
                   3    9    2    4    4    8
                   2    1    7    6    7    8
                  32   48   57   41   42   50   270

   ANALYSIS OF VARIANCE:
        VAR           SS         DF        MS         F
        TOTAL       202.00       53
        BETW         41.33        5       8.27       2.47
        WITH        160.67       48       3.35
        A/EFF          .30        1        .30        .09
        B/EFF        32.11        2      16.06       4.80
        INTER         8.93        2       4.46       1.33

   SUMMARY OF CORRELATIONS OF ONE ARRAY WITH 5 FACTORS:
         F1          F2          F3          F4          F5
         PER         PER/LT      LT          AU/LT       AUT

        .5842       .6436       .7871       .7574       .5000
```

FIGURE 10

ILLUSTRATION OF COMPUTER OUTPUT FOR ANALYSIS OF GROUP PERFORMANCE ON DESIGN II-2

```
ELEMENTARY TEACHERS, DESIGN II-2, MODAL ARRAY

  DISTRIBUTION MATRIX:

         63   96   33   16   35   46   54   81   31
         82   86   43   32   94   64   83   51   91
              93   36   62   21   75   44   71
              23   53   95   55   26   92   61
                   11   41   76   66   84
                   42   73   52   34   74
                        14   45   13
                        56   25   12
                        72   65   22
                             24
                             85
                             15

  SCORE MATRIX:

              7    4    4    6    5    6
              5    4    8    5    5    4
              1    6    7    4    5    7
              6    7    7    3    5    4
              2    5    7    3    5    6
              2    6    9    4    5    4
              2    6    6    3    4    5
              2    9    3    3    5    8
              1    3    8    5    6    8
             28   50   59   36   45   52        270

  ANALYSIS OF VARIANCE:

        VAR          SS         DF         MS          F
        TOTAL     202.00        53
        BETW       71.11         5      14.22       5.22
        WITH      130.89        48       2.73
        A/EFF        .30         1        .30       0.11
        B/EFF      63.44         2      31.72      11.63
        INTER       7.37         2       3.69       1.35

  SUMMARY OF CORRELATIONS OF ONE ARRAY WITH 5 FACTORS:

          F1          F2          F3          F4          F5
          PER       PER/LT        LT        AU/LT        AUT

        .5842       .6980       .8762       .8317       .4901
```

FIGURE 20

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, ELEMENTARY TEACHERS, ON EVENTS II-1, II-2
(Data derived from Figures 22 and 23)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.5842	.6436	.7871	.7574	.5000
II-2	.5842	.6980	.8762	.8317	.4901
Correlation differences	.0000	.0544	.0891	.0743	-.0099
Student t	0.00	1.28	3.13**	2.26*	-.19
Correlation II-1, II-2	.9110				
z' transformation, II-1			1.063		
z' transformation, II-2			1.358		
$z_2' - z_1'$			.295***		

**p < .01; *p < .05; by test of nonindependent r's (23:85).

***Not a statistically significant difference by method of test of independent r's (23:82).

authoritarian and learning and teaching correlated? A discussion of these factors is given in the section devoted to the development of factor arrays.

For a test of change of attitude, or change in point of view of the group, one may consider a test of difference between two correlation coefficients bearing on the same matter. For example, the test of differences of two correlation coefficients relating to the same factor, by use of a procedure developed by Hotelling (46) is illustrated next. The procedure involves a test of significance of the difference between two correlation coefficients when the two values are not independent. The basic formula used is as follows (23:85):

$$t = (r_2 - r_1)\sqrt{\frac{(N - 3)(1 + r_{12})}{2(1 - r_1^2 - r_2^2 - r_{12}^2 + 2r_1r_2r_{12})}}$$

In illustration of the test of significance of the difference in factor 3, F3 LT, in Figure 20, appropriate values from Figures 18 and 19 are taken, a value for r_{12} is computed, and all are substituted in the formula, with the following result:

$$t = (.0891)\sqrt{\frac{51(1 + .91)}{2(1 - .62 - .77 - .83 + 2x.79x.88x.91)}}$$

$$t = 3.132$$

N is the number of items in a Q-sort, and r_{12} is the correlation computed by means of the simplified Pearson r formula, which is the correlation between the two arrays II-1 and II-2. Hotelling, in deriving the formula for t, presents the final expression in this form (46:278):

$$t = (r_2 - r_1)\sqrt{\frac{n(1 + r_o)}{2D}}$$

where D is defined as:

$$D = \begin{vmatrix} 1 & r_1 & r_2 \\ r_1 & 1 & r_o \\ r_2 & r_o & 1 \end{vmatrix}$$

The probability of a greater value of $|t|$ is given by the tables of Student distribution, with $n = N - 3$. If this probability is sufficiently small, which will be taken in this study as being less than .01, there is a corresponding degree of confidence that the variate chosen because of higher correlation in the sample has actually a higher correlation than the other in the population. By this criterion the value of t given above, $t = 3.132$, is significant, and it can be stated with some confidence that there was an increase in appreciation for factor F3, LT, in the illustrated example.

Since the principal task of this chapter is the development of research procedures and statistical formats, the interpretations of statistical matters is held in abeyance until the results are assessed in a later chapter. However, it is of interest to note in the foregoing analysis that the gain in correlation of the group of elementary teachers was in the direction of increased appreciation of concepts relating to learning and teaching. This trend would be a logical one especially for beginning teachers.

The analysis of performances by groups gains significance from inspection of the correlations with empirically-derived factors or types. The spectrum of correlations indicates the nature of relative emphasis of predilection of the group. The process of computing a factor array, and correlating a group performance with that array, is essentially an empirical approach to a conclusion. There can be two main streams of analysis which are parallel, complementary, but essentially different in principle. An analysis of variance approach, which should corroborate the empirical result described in this section, is of an a priori character. If there is some reason to believe that both types of analysis are needed to obtain corroborational evidence in the determination of status and change, a second procedure can be used using an analysis of variance approach. This additional evidence may be felt to be necessary in order to gain some further assurance that there is indeed order and uniformity in the examination of human behavioral phenomena.

As with most of the statistical procedures described herein the computational aspects are exceedingly laborious when done by hand, and the full use of Hotelling's formula for test of all comparable correlations is no exception. Computer program SUMCA makes the matter comparatively simple,

producing an output for the illustrated case shown in Figure 20. This format is useful for comparing nonindependent r's for groups as illustrated, or for individuals with the same type of data.

FIGURE 21

ILLUSTRATION OF SCORE MATRIX COLUMN TOTALS FOR ELEMENTARY TEACHERS ON DESIGN II-2

(N = 25)

Cell	1 ad	2 ae	3 af	4 cd	5 ce	6 cf	Person, Serial and Event Number
	44	48	54	47	36	41	5131 2
	31	50	56	39	38	56	5132 2
	29	42	57	32	49	61	5133 2
	25	56	55	32	46	56	5134 2
	23	55	52	30	56	54	5135 2
	44	47	46	49	44	40	5138 2
	39	52	50	37	42	50	5139 2
	24	40	54	45	51	56	5140 2
	41	49	55	35	43	47	5141 2
	33	52	55	39	36	55	5142 2
	37	53	42	40	50	48	5144 2
	34	39	49	47	50	51	5146 2
	41	43	47	49	41	49	5147 2
	38	39	44	52	51	46	5149 2
	45	51	56	38	35	45	5151 2
	40	40	51	41	44	54	5153 2
	41	43	55	39	47	45	5154 2
	32	49	53	38	48	50	5155 2
	35	49	59	27	46	54	5156 2
	39	35	56	49	49	42	5157 2
	50	43	52	44	37	44	5158 2
	34	53	58	30	47	48	5160 2
	24	47	46	55	57	41	5162 2
	45	43	58	38	36	50	5163 2
	26	43	55	47	47	52	5164 2
Sums	894	1161	1315	1019	1126	1235	

FIGURE 22

A PARADIGM ILLUSTRATING EMPIRICAL DATA DERIVED FROM COLUMN SUMS OF 25 Q-SORTS AND ANALYSIS OF VARIANCE GIVEN IN FIGURE 21

A: Educational Philosophy:		PER	AUT	Sums
B: Educational Operations:				
General Culture	GC	894	1019	1913
General School Objectives	GS	1161	1126	2287
Learning and Teaching	LT	1315	1235	2550
Sums		3370	3380	6750

ANALYSIS OF VARIANCE:

VAR	SS	DF	MS	F ratios
TOTAL	10240.00	149		
BETW	4563.75	5	912.75	23.15**
WITH	5676.23	144	39.41	
A/EFF	.66	1	.66	.01
B/EFF	4098.75	2	2049.37	51.99**
INTER	464.33	2	232.16	5.88**

$^{**}p < .01$

Analysis of Variance of Group Results

The development of the analysis of variance approach to consideration of group performances begins with the assembling of the individual score matrix column totals, taken from the computer output from individual performances. TABLP punches cards for this type of data. Figure 21 presents the data, as representative, for the same group previously illustrated in Figure 19 which gives the results of the performance on design II, second occasion.

In Figure 21 are assembled the column scores from score matrices of 25 elementary teachers in experimental comparison group X5. In an analysis of variance sense each row can be considered as six experiments on one person, and each column can be interpreted as a replication of 25 experiments in a factorial design. From the sums of columns an estimate can be made of the group's predilection, by arranging the column scores in the order of the factorial design. A cursory study of the data so arranged indicates that the group has a predilection for learning and teaching, but no particular preference for either level of educational philosophy. Analysis of variance illustrates significant F-ratios in B/EFF and INTER. Homogeneity of variance test made on the input data gives a chi square of 4.01, which lacks significance, and showing homogeneity of data. A chi square computation made on the contingency table of the sums in the factorial design in Figure 22 yields a significant value of 11.19. This may be considered a test of relationship that might exist in the two main effects, A and B. For two degrees of freedom, a value of 11.19 is significant, and some relationship might be expected requiring explanation. This matter is also paralleled by the significant interaction in the analysis of variance, abbreviated INTER. The interaction may be explained, when in considering the population sampled have indicated a preference for authoritarian statements reflecting the culture, but would prefer a permissive view with respect to the school and classroom.

The significant F-ratios are interpreted in light of the hypotheses applying to the factorial design. A significant F-ratio in the A/EFF would be sufficient evidence of a significant difference in the means of the levels of PER and AUT. There is no expectation that either level will surpass the other. A significant difference in means in the B/EFF is expected by hypothesis, that is, it is expected that

LT > GS > GC. Winer (89:85) states that if meaningful comparisons are relatively few in number, and are planned before the data are obtained, the F-test associated with the individual components of variation should be used; this type of comparison is called an a priori comparison, in contrast to comparisons made after inspection of the experimental data. The standard error of difference which may be used in comparing means of B/EFF is expressed by formula given by Guilford (35:264). This formula uses the value of the within sum of squares mean as an estimate of population variance.

The foregoing analysis of variance approach to the consideration of group performance may be summarized as follows:

1. Summing of column totals, forming of sums into the order of the factorial design.
2. Computation of chi square on sums of data to determine relationship, if any, between effects A and B.
3. Test of homogeneity of variance of input data.
4. Analysis of variance of data.
5. Comparison of means, by means of statistics obtained from analysis of variance.

The net effect of performing the above steps is to gain some estimate of the significant differences of means, which may indicate something of importance in the group performance. In particular, it does appear that the group holds that:

LT >GS >GC*

with no other outstanding finding except for the presence of interaction in the level of general culture. The latter was explained by the statement that the group indicates a preference for authoritarian statements reflecting the culture, but prefers a somewhat permissive view in matters pertaining to the school and the classroom.

---

*This may be interpreted to mean that the three factors are significantly different in direction of the > signs.

Development of Factor Arrays

General Procedure for Computing Factor Arrays

The general procedure for computing factor arrays for a particular Q-sort design involves the following steps:

1. The collection of sufficient numbers of individual Q-sorts for a factor analysis. The necessary data include the Q-sort score matrices and analyses of variance of individuals. The number in such a collection that is considered sufficient is a matter of judgment, and is also subject to the availability of experimental persons. It was found convenient to provide a system of "flags," or cue factors, to identify preliminary estimates of factors in a factor analysis. This is done by collecting arrays of individuals which have very similar indications evidenced in records of analysis of variance, and thus gain an advance definition in approximation of a factor. By adding all scores for each statement of a set of arrays in the manner as indicated for gaining a modal personality of a group, described in the previous section, a modal array for a prospective factor is obtained. This "flag" used as an array in the factor analysis correlation matrix serves to indicate approximately where the centroid of the factor may be located in the graphic plot of the person variables taken from the factor matrix.

2. The hypothetical grouping of Q-sorts into clusters or types of arrays, based on examination of the analyses of variance results, and the expectation of the experimenter from the a priori nature of the Q-sort design. In this study only persons with statistically significant indications in the analyses of variance in their arrays were chosen as contributors to the hypothetical groupings.

3. The computation of a correlation matrix of individual arrays bearing on a design. This step is usually the first in a factor analysis of a set of raw scores, but here the correlation matrix is used as a means for further refining the grouping process specified above. The assumption underlying this procedure is that variables, which are persons, of a set of variables identifying a factor, have a higher intercorrelational relationship than with the other variables of the total set of variables, or persons, being considered.

4. A factor analysis of the hypothetical grouping of variables, or persons. The logic of procedure is that factor analysis is simply a statistical tool. Through the simplification of the correlation matrix of grouped variables there is accomplished a kind of test of the groupings; that is, there is a kind of test of the hypothesis of an a priori education theory represented in the Q-sort design.

5. The identification of the hypothetical groups of variables comprising factors. The identification is greatly assisted by a graphic plot of certain of the factors of the factor matrix gained from factor analysis. Through each identified group a centroid is drawn and the factor loading of each contributing variable is measured graphically. This is a necessary bit of information for computing weighted arrays.

6. The computation of factor arrays, using procedure outlined by Stephenson (61:174). Computer program FACCO was developed to accept factor loadings and numerical definitions of individual variables, compute weighted factor arrays, and punch cards for an ad hoc analysis of variance test of each array.

7. An ad hoc analysis of variance test of each factor array developed in the foregoing steps. Such a test serves to give assurance to the product, and particularly helps in detecting errors, and as a validation check.

Typical Results of Factor Analysis, Design II

Certain graphic results of factor analysis of data pertaining to design II of the 1964 series are indicated in Figure 23. The computer program, using what is known as the principal-factor method of factoring (41:154), accepted a correlation matrix of 50 x 50 dimensions. The first five variables were "flags," which indicated an expectation that the following correlated person groups or factors would be identified:

Abbreviation	Suggestive Description
PER	Permissive
PER/LT	Permissive correlate with learning and teaching
LT	Learning and teaching without educational philosophical commitment
AUT/LT	Authoritarian correlate with learning and teaching
AUT	Authoritarian

In Figure 23 the "flags" clearly stand out, and also are fairly good indicators of the disposition of the 45 experimental persons, whose arrays are chosen to make contributions to the definition of factor arrays.

In the illustrated plot the tentative grouping of 50 variables was with the expectation that the first five would be the flags, identified by above abbreviations. The next eight were arrays of persons, that is, 6 through 13 making contributions to PER as evidenced in their analyses of variance. PER/LT was represented by 14 through 26, LT by 27 through 32, AUT/LT by 33 through 43, and AUT by 44 through 50. While the general expectation of the disposition of variables appears to be fulfilled, it is also evident there are a few surprises in the clustering. Suggestive centroids for the factors are indicated by dashed lines, and the projections of prospective contributors to definition of the factor are measured. For example, factor AUT would seem to be appropriately defined by the variables listed in the following table, arranged in rank order of loadings:

Person (variable)	Loading
46	.82
49	.80
38	.76
50	.73
44	.64
47	.57
45	.51
48	.46

The graphic plot that has been illustrated represents the usual first step in what is known as rotation of axes of a factor matrix, in that the arguments for identifying a point is in terms of the loadings on the first two listed factors in the factor matrix. The cumulative variance in the first two factors in the instant case is 51 per cent. Sufficient evidence is contained in this plot to carry on the determination of factor arrays, and no further action in way of rotation is considered necessary. Hand plotting is usually laborious and can be very readily done by a scatter plotting by computer program. Figure 23 represents a tracing of a computer output in which the first two factors are used as arguments, to scale of one inch equals .2 in a factor loading.

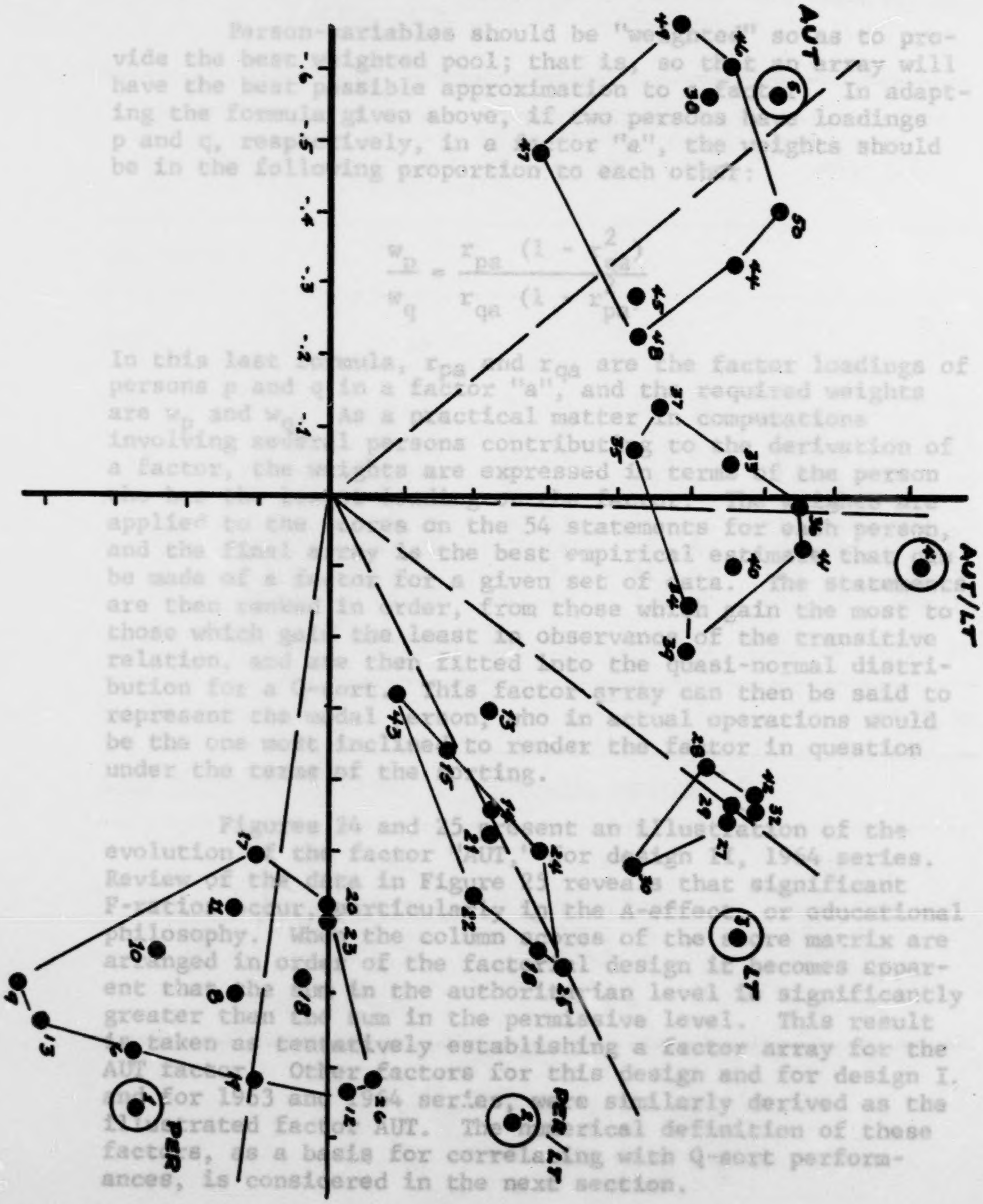
Computation of Factor Arrays

Factor arrays are very useful as typological reference points to which a person's Q-sort performance may be correlated. They are applicable only to a specific Q-sort design, and to the specific assembly of statements describing that design; they may not apply to parallel forms of the same design. Thus each design, after it is validated and printed up for use, requires an individual development of factor arrays that will be used with it. This does not imply the uniqueness of the factor arrays for the specific design, as it is certain the derived factor arrays can be improved for a specific design.

The basic formula for computing factor arrays, as given by Stephenson (76:120), adapted from Spearman, reads as follows:

$$\frac{w_b}{w_a} = \frac{f_b\ (1 - f_a^2)}{f_a\ (1 - f_b^2)}$$

FIGURE 23. GRAPHIC REPRESENTATION OF FACTORS, DESIGN II



If f_a and f_b are the factor loadings for factor f in the two variates, a and b, the "weights" for the scores gained by any statement are in the proportion given above.

Person-variables should be "weighted" so as to provide the best weighted pool; that is, so that an array will have the best possible approximation to a factor. In adapting the formula given above, if two persons have loadings p and q, respectively, in a factor "a", the weights should be in the following proportion to each other:

$$\frac{w_p}{w_q} = \frac{r_{pa}\ (1 - r_{qa}^2)}{r_{qa}\ (1 - r_{pa}^2)}$$

In this last formula, r_{pa} and r_{qa} are the factor loadings of persons p and q in a factor "a", and the required weights are w_p and w_q. As a practical matter in computations involving several persons contributing to the derivation of a factor, the weights are expressed in terms of the person who has the [illegible] loading in the factor. The weights are applied to the scores on the 54 statements for each person, and the final array is the best empirical estimate that can be made of a factor for a given set of data. The statements are then ranked in order, from those which gain the most to those which gain the least in observance of the transitive relation, and are then fitted into the quasi-normal distribution for a Q-sort. This factor array can then be said to represent the modal person, who in actual operations would be the one most inclined to render the factor in question under the terms of the sorting.

Figures 24 and 25 present an illustration of the evolution of the factor "AUT," for design II, 1964 series. Review of the data in Figure 25 reveals that significant F-ratios occur, particularly in the A-effects, or educational philosophy. When the column scores of the entire matrix are arranged in order of the factorial design it becomes apparent that the sum in the authoritarian level is significantly greater than the sum in the permissive level. This result is taken as tentatively establishing a factor array for the AUT factor. Other factors for this design and for design I, and for 1963 and 1964 series, were similarly derived as the illustrated factor AUT. The numerical definition of these factors, as a basis for correlating with Q-sort performances, is considered in the next section.

If f_a and f_b are the factor loadings for factor f in the two variates, a and b, the "weights" for the scores gained by any statement are in the proportion given above.

Person-variables should be "weighted" so as to provide the best weighted pool; that is, so that an array will have the best possible approximation to a factor. In adapting the formula given above, if two persons have loadings p and q, respectively, in a factor "a", the weights should be in the following proportion to each other:

$$\frac{w_p}{w_q} = \frac{r_{pa}\ (1 - r_{qa}^2)}{r_{qa}\ (1 - r_{pa}^2)}$$

In this last formula, r_{pa} and r_{qa} are the factor loadings of persons p and q in a factor "a", and the required weights are w_p and w_q. As a practical matter in computations involving several persons contributing to the derivation of a factor, the weights are expressed in terms of the person who has the lowest loading on the factor. The weights are applied to the scores on the 54 statements for each person, and the final array is the best empirical estimate that can be made of a factor for a given set of data. The statements are then ranked in order, from those which gain the most to those which gain the least in observance of the transitive relation, and are then fitted into the quasi-normal distribution for a Q-sort. This factor array can then be said to represent the modal person, who in actual operations would be the one most inclined to render the factor in question under the terms of the sorting.

Figures 24 and 25 present an illustration of the evolution of the factor "AUT," for design II, 1964 series. Review of the data in Figure 25 reveals that significant F-ratios occur, particularly in the A-effect, or educational philosophy. When the column scores of the score matrix are arranged in order of the factorial design it becomes apparent that the sum in the authoritarian level is significantly greater than the sum in the permissive level. This result is taken as tentatively establishing a factor array for the AUT factor. Other factors for this design and for design I, and for 1963 and 1964 series, were similarly derived as the illustrated factor AUT. The numerical definition of these factors, as a basis for correlating with Q-sort performances, is considered in the next section.

FIGURE 24

STATISTICAL DATA IN EVOLUTION OF FACTOR "AUT" ARRAY, DESIGN II OUTPUT OF PROGRAM FACCO

Sums of weighted scores of statements of person-variables 46, 49, 38, 50, 44, 47, 45, and 48, having loadings on hypothetical factor AUT of .82, .80, .76, .73, .64, .57, .51, and .46, respectively.

SUM MATRIX

Cell	1 ad	2 ae	3 af	4 cd	5 ce	6 cf
Row 1	74.85	84.76	36.44	115.56	107.41	133.43
2	79.60	69.96	83.76	117.71	104.65	121.96
3	72.73	60.66	60.34	101.81	122.55	160.83
4	57.80	76.78	65.00	132.73	114.92	132.86
5	62.04	80.81	57.93	122.08	90.49	143.52
6	70.62	96.74	72.61	100.16	115.45	147.17
7	84.63	88.00	71.46	98.81	94.86	133.11
8	61.44	89.34	75.71	116.67	108.73	117.76
9	88.01	46.76	61.15	134.88	142.22	161.52
Sums	651.72	693.81	584.39	1040.42	1001.29	1252.16

Grand sum: 5223.79

SUMS ARRANGED IN ORDER OF FACTORIAL DESIGN

	PER	AUT	Sums
GC	651.72	1040.42	1692.14
GS	693.81	1001.29	1695.10
LT	584.39	1252.16	1836.55
Sums	1729.92	3293.87	5223.79

FIGURE 25

ILLUSTRATION OF COMPUTER OUTPUT FOR ANALYSIS OF PROSPECTIVE FACTOR "AUT," DESIGN II

```
FACTOR AUT, DESIGN II, 1964 SERIES

DISTRIBUTION MATRIX:

        96   66   16   26   25   23   61   32   92
        36   56   76   86   34   52   22   33   13
             95   46   24   64   21   43   53
             94   44   84   74   42   51   41
                  35   14   62   83   81
                  54   65   75   11   93
                       45   55   31
                       85   82   63
                       15   91   73
                            72
                            12
                            71

SCORE MATRIX:

              4    5    1    6    6    7
              4    3    4    6    5    6
              4    2    2    5    7    9
              2    4    3    7    6    7
              3    4    2    7    5    8
              3    5    4    5    6    8
              5    5    4    5    5    7
              3    5    4    6    6    6
              5    1    3    8    8    9

             33   34   27   55   54   67   270

ANALYSIS OF VARIANCE:

   VAR          SS       DF        MS         F
   TOTAL      202.00     53
   BETW       139.33      5      27.87      21.34      p <.01
   WITH        62.67     48       1.31
   A/EFF      124.52      1     124.52      95.38      p <.01
   B/EFF        1.33      2        .67        .51
   INTER       13.48      2       6.74       5.16
```

The above described process serves as a kind of validation check of the appropriateness of statements in the design; for example, it would be expected that AUT factor would emphasize all statements in cells of this level, that is, for cells cd, ce, and cf. Inspection of the sum matrix in Figure 24 indicates that in general this was the case.

The listing of factors for design II that includes PER, PER/LT, LT, AUT/LT, and AUT was found to be adequate for the 1963 and 1964 series. The numerical definitions of these factors for both series are given in the following section.

Numerical Definition of Factors

The derived factors with which individual arrays may be correlated to determine predilection as an empirical matter are defined in this section. The factors, as mathematical entities, can be likened to matrices and described as subscripted variables, such as X_{ij}, in which i corresponds to the row number, and j corresponds to the column number of the matrix X. The score matrix of the individual Q-sort is considered in the same manner. In computing the correlation between an array of a person and a factor the relationship is given by the following expression:

$$r_{xy} = \frac{\Sigma XY - 1350}{202}$$

Thus, a correlation is a summation of 54 products of identical elements in two matrices of the scores assigned to the 54 statements of a Q-sort and the scores assigned to the 54 statements representing the factor, where X may represent the individual array and Y the factor array.

Another matter of interest in connection with the numerical definition of a factor is that the order of the statements in the factor, starting from the most significant and extending through to the least significant statement, constitutes the definition of the factor in terms of relative significance of the statements and their relation to the sorting instructions. That is, if one should read through a factor, starting with the most significant statement, and extend the reading in succession to the least significant statement, one would gain what the teaching type represented by that factor would consider appropriate for the sorting instruction.

The meaning of the order of the numbers in the numerical definitions of factors may be represented by the following mathematical expression:

$$((X(I,J), J = 1,6), I = 1,9).$$

The last expression, in computer terminology, says that, in the reading of a set of scores of statements in array X, first read values in the columns 1 through 6 for the first row, then in the same manner repeat the reading of columns for succeeding rows until nine rows have been read. This will accomplish the reading of 54 statements, which are represented in a typical score matrix.

The numerical definition of factor AUT in Q-sort design II, which has been explained in the previous section, is read off as a row of integers, or scores, but with the above understanding as to the significance of the order; for example:

451667434656422579243767342758354568554557354666513889 AUT II

Translated into a score matrix format the above array reads as it appears in the score matrix of Figure 25.

Tables 2 and 3 list the numerical definitions of factors that have been developed in this study.

With an understanding of the system of numerical definition of factors one can study the listing of statements of a particular design, given in the Appendix; and by following the order of significance as evidenced by the scoring, there is obtained a complete statement of the factor. For example, in reading off the meaning of factor AUT, that has been described, one starts with the 9's, that is, statements 96 and 36, then the 8's, that is, statements 66, 56, 95, and 94. Continuing this process through the scores of 1 there is gained a complete statement of the factor. The suggestive titles for factors are to be considered names only, and do not represent much of the content.

A convenient scale is provided at the bottom of each table, by which it is possible to identify the cell and replication represented by any score item in the numerical definitions above the scale. By laying a ruler down parallel to the edge of the page the reading is made an easy matter.

Recapitulation

This chapter, devoted to statistical methods that are appropriate for Q-methodology, has presented detailed confirmation of hypotheses of methodological character, posed in the first chapter. In particular, there is presented a system of data processing, using computer technology, for carrying on all computations characteristic of

TABLE 2

NUMERICAL DEFINITION OF THE FACTOR ARRAYS, DESIGN II, 1963 SERIES

Q-SORT DESIGN II:

Factor PER

766244648544367645768125558233579434367526583557456519

Factor PER/LT

667646558534259546678335237515469544166527475448357328

Factor LT

655657348554168467577146256366258445257346485359237349

Factor AUT/LT

464657457655147367568265247546258345155547383369236489

Factor AUT

452967536653127688544475345758367556444366351587224596

Scale:
Cell

123456123456123456123456123456123456123456123456123456

Replication

111111222222333333444444555555666666777777888888999999

TABLE 3

NUMERICAL DEFINITION OF THE FACTOR ARRAYS, DESIGN II, 1964 SERIES

Q-SORT DESIGN II:

Factor PER

667447558251669553658454379544588432657325667431567423

Factor PER/LT

586538457143659445647365179556478255646226657442378335

Factor LT

465549247356458365546267169458388356446237456355257177

Factor AUT/LT

362738235557446278446568257567367569355416535446144589

Factor AUT

451667434656422579243767342758354568554557354666513889

Scale:
Cell

123456123456123456123456123456123456123456123456123456

Replication

111111222222333333444444555555666666777777888888999999

Q-methodology that were considered in this study. The devisement of such a system was considered essential for making Q-methodology a practical matter in education, either for instruction or for research. This consideration stems from a belief that theoretical developments in the field of education that have promise of utility are best presented when they are coupled with practical methods of implementing the development; this is principally due to a variation of the same belief that educators are probably more implementers, rather than theoreticians.

A type of validation, called semantic validation, is presented which illustrates the application of aspects of information theory. This development is considered to be of importance in the development of Q-sorts, and has utility in general as a kind of reading comprehension test. Scores are obtained in the form of "bits," which represent the amount of information which a person transmits following exposure to a semantic stimulus. In the validation process, the answer to the question concerning the uncertainty the investigator for a semantic stimulus is gained, and in terms of the same measure. The exploitation of the possibilities of the method as a reading test are explored in the next chapter devoted to results.

Q-sort statistics are presented in such a manner that the analyses of individual performances can be considered in their own right, such as in the context of "action research," or as basic raw data for further consideration of group performances. The analytical consideration of the performances of a relatively homogeneous group, with certain common goals and problems placed before them in a social situation, such as school objectives, should result in a statement that indicates the nature of the commonality. These are extremely important matters in education, and constitute a necessary feedback as to the appropriateness of teacher education, such as in the instant study. The concept of the "modal" person is developed in this chapter, and the correlations of the modal person arrays with teaching types on one or more occasions give a source of information as to the status of predilection of the group, and of the nature of change of predilection. Statistical methods are presented which bear on both problems.

The typological character of this study is emphasized by the empirical development of factor arrays, which serve as reference points for assessment of predilections of individuals or of modals. While the "types," or factors, as they are called without essential distinction, bear suggestive titles as to the nature of the type, it is essential that a full array of the statements of the Q-sort be reviewed in order to gain a complete definition of the factor. This is hardly practicable for publication, except in the manner that has been presented in this chapter. The procedure is to take a numerical definition of a factor, and by referring to the coded identification of statements in the Appendix and the rank order of scores of statements in the factor, the highest order of predilection to the condition of low predilection or aversion to statements can be assessed. This follows from reading straight through a sequence of statements, and which thus represents a kind of spectrum of thinking, in terms of the sorting instruction.

The utility of the numerical definitions of factors is greatest in terms of their use in computer programs. When coded definitions are used as an auxiliary kind of input, along with the Q-sort arrays of individuals, the program analysis permits the computation of correlations of the array with the various factors. These additional data give much greater meaning to the performance.

The above discussion has summarized the efforts to confirm hypotheses 3.2, 3.3, 3.4, and 3.5. Hypothesis 3.1 required a statement of an adequate theory for the study, and this was presented in the last chapter. Hypothesis 3.2 specified that semantic validation could be accomplished by application of information theory. Hypothesis 3.3 required the devisement of a system utilizing computer technology that would handle the computations of the study. Hypotheses 3.4 and 3.5 pertained to the verification of the factorial structure of the Q-sorts, and to the development of factor arrays for design II.

CHAPTER V

RESULTS OF THE STUDY

Introduction

The motivation for the psychological aspects of the study was developed through concern for two basic questions of importance in education, and specifically pertaining to the possibilities for assessing affective behaviors of persons engaged in teaching:

1. Can affective behaviors relating to education and teaching be assessed in student teachers during their teaching apprenticeship?

2. Can changes in affective behaviors relating to education and teaching be assessed in student teachers during their teaching apprenticeship?

The resulting general propositions derived from the foregoing questions were not tested for their general implications, but served toward formulation of singular hypotheses. In general, it was affirmed that the status of affective behaviors and changes in affective behaviors, relating to education and to teaching, could be assessed reliably by Q-methodology. It was also considered possible that the research questions could be extended to others in education, such as master teachers.

In order to guide the study it was felt necessary to specify certain additional, methodological, hypotheses. These methodological matters stemmed from the feeling of necessity for validating new testing instruments, for volume processing of data, and for proceeding from the basis of an adequate theory relating to affective behaviors. Chapter II presents the aspects of theory which essentially are a confirmation of the hypothesis (3.1) relating to the possibilities for testing by Q-methodology. Without an adequate and psychologically sensitive theory from which to proceed, it is considered not possible to effectively attack the singular propositions relating to effective behaviors of individuals and groups. Without adequately validated testing instruments it would be equally impossible to view results with confidence. The necessity for volume data processing has been a stimulus for development of computer programs. It may be seen that the pyramiding of developments of a methodological nature, and which have been described in the previous chapters, constitute the main operational structure of the study.

The nature of the results that can be expected from the study of affective behaviors, utilizing Q-methodology, is centered about the individual case. Stephenson, the founder of the Q-methodological approach to the study of psychological problems, advocates acceptance of the importance of the self concept, or centrality of self, and the basing of psychological mensuration on the single case. Stephenson's basic unit of consideration involves a person's self-referent statements or notions, made in relation to interactional situations. The unit, or basic element, is described by Stephenson as a person X, involved in social conditions Y, and with mediating circumstances Z. The relation of the experimental persons to conditions Y in this study has been described. In order to ensure a commonality of attention of all persons to Q-sorting, the instructions, or mediating circumstances Z, in the testing were the same. The instructions, which were of a self-referent kind, requested that each person sort statements of the Q-sort into an order of importance or significance to him, and in terms of his role as a teacher in a classroom situation in which he was serving.

Following the development of data for the individual case, the natural extension of interest, for education particularly, is to consideration of the group, and to the possibilities in Q-methodology for defining classes of variates, or types, and for providing summary statements of the performances of groups as modal persons. The typological character of the study is reflected in the reliance on correlations of performances of individuals and modal persons in design II with factors, or types. The further pyramiding of developments in this study thus follows from consideration of the individual as furnishing basic data for consideration of the group. Almost every successive development has depended upon successful accomplishment of preceding aspects.

Design II offers an opportunity to assess the preferences of subjects and groups for permissive and authoritarian aspects of teaching. The factorial design in this case is relatively simple, lending itself for definition of correlates of the philosophical aspects with statements bearing on teaching and learning, and which have resulted in the numerical definitions of typological factors PER, PER/LT, LT, AUT/LT, and AUT. Assessment of a status of a preference is obtained by either from viewing an array of correlations of a single performance with the typological factors, or by analysis of variance of the performance. Since the factor analysis of performances on design II has fairly well substantiated the fidelity of that design to reflect its a priori character empirically, either method of assessment will serve. The principal differences in the types of analysis are found in the variations in the sensitivity of tests of statistical significance, particularly in relation to changes. A unique method of assessing changes is illustrated in the use of Hotelling's t test for changes in correlation coefficients. Analysis of variance takes on a minor role in consideration of assessment of changes in individuals and groups.

Design I, in addition to offering opportunity for assessment of the preference for permissive and authoritarian points of view, provides for assessment of preferences for the academic, social and vocational objectives of education. Factor analysis of design I provided substantiation for the fidelity of the design, and the typological character of a performance is easiest presented by analysis of variance, particularly in the case of performances of groups.

Results in Terms of Individuals

Consideration of Individual Changes in Terms of the Hypotheses

The first consideration of results is given to those that bear on the hypotheses pertaining to individuals, that is, to hypotheses 1.1 and 1.2. It was expected that experimental persons in all groups would render statistically significant correlations for a teaching type in a majority of cases. This hypothesis was more than realized, but the presentation of an entire historical record to substantiate the fact is not desirable. Certain illustrative data are presented however that show further possibilities in the use of individual data for instruction and for counseling. In Table 4 there is presented the cases of two girls who occupy certain extremes in status as teachers or teacher apprentices. The first, serial 8008, entered teaching with a provisional credential, and commenced teaching from the beginning; the second, serial 6041, is a junior taking her first course in education, and has had no teaching experience. Other things being equal the greatest difference, experience-wise, is that one had assumed an appreciable teaching responsibility, while the other had been an observer. It is from review of the type of data contained in this table that one determines much more than that a majority of experimental persons have a statistically significant predilection for a teaching type, as revealed by correlations of their Q-sort arrays with factor arrays.

Due consideration is to be given to the significance level for a correlation (22:209); for example, Fisher gives for n = 50, at the .01 level, a value of .3541. For purposes of obtaining a rough estimate of whether a person's performance had a significant correlation with a given factor, a rounded figure of .35 seems appropriate. Of about 157 persons tested in the 1963 series, only about seven failed to gain a significant correlation of .35 or better with an empirically-derived factor. This does not mean that all correlations give highly significant information, as many arrays do not indicate a clear picture of the situation. The results do indicate that, in a majority of experimental cases, there were Q-sorts rendered to which some rational interpretation can be made in the hypothesized matters. Even with low correlations, such as illustrated in case of serial number 8008, the method of analysis by correlations with factors reveals rather significant information.

The method of comparing correlations, making use of Hotelling's formula (46) that is illustrated in Table 4, also gives a great deal more meaning to performances. Some further statistical guidelines are helpful, that will be explained. It was expected that design II would be sensitive enough to detect the changes that occurred in individuals and in groups; the matter of change in affective behaviors was one of the major objects of interest in this study. The general expectation that change would be identifiable was expressed in hypothesis 1.2, for individuals, and in hypothesis 2.6, for groups. In the latter, not only was it expected that change would be detectable, but it was specified that change would take place in the novice teaching groups in direction of appreciation for matters bearing on teaching and learning, that is, for the content of factors PER/LT, LT, and AUT/LT. Thus, statistically speaking, a one-tail test of significance for LT is appropriate, and applicable to a lesser degree for factors PER/LT and AUT/LT, when considering the performances of groups. Changes in PER and AUT were not hypothesized as to direction, so a two-tail test applies. Approximate guidelines for statistical interpretation of the changes in a display of correlations with factors, such as in Table 4, and in consideration of the above discussion, are as follows:

Probability level (p)	Student t for Significance	
	PER, AUT	PER/LT, LT, AUT/LT
.10	1.67	1.30
.05	2.01	1.66
.01	2.67	2.38

The interpretation of the nature of the changes in the comparisons of correlations is now gained by two complementary kinds of considerations:

1. Comparing the listed statistical guidelines above, with the correlations, their differences, and with the computed Student t values.

2. Noting the orderly nature of the variations of the correlation differences, and computed

Student t values, from factor to factor through the entire spectrum, going from left to right in the data, or vice versa.

For example, it may be seen in Table 4 that the beginning teacher whose serial is 8008 evidenced a rather marked shift in predilection to the right in the spectrum, with significant increases in factors LT, AUT/LT, and AUT, with the greatest increase centered in AUT/LT. In a certain sense this shift can be attributed to the necessity for facing a large responsibility in the classroom for the first time. The contrast of the above with the stability of the experimental person whose serial is 6041 is also remarkable. The latter person is still a student, who has no responsibilities in the classroom other than observing as part of the education class requirement.

Only a very brief summary of the possibilities for interpretation of data has been given relating to the cases above, but the necessity for having augmenting information relating to performances has been made clear. A further bit of information which possibly accounts for the attenuation in the correlations in the case of the beginning teacher, but which otherwise characterizes a highly responsible attention to Q-sorting, is to be found in the nature of the T-scores listed. The transformation of the T-scores into an equivalent, and possibly more meaningful, measure of a cognitive performance is also given in the value of "r", which might also be considered a proportion of information transmitted to information received. It will be noted that person 6041 gained a T-score of 2.498 (r = .907), which is close to the theoretical maximum of 2.585. Person 8008 has a T-score of 1.070 (r = .7237), which is less than average for all of the experimental persons participating. It is deserving of attention to note the possible relation between cognitive behavioral performances and affective behavioral performances. It does seem apparent that the girl with the lower measure of cognitive ability was definitely able to make an impressive record of the shift of her feelings toward teaching, as a result of her teaching experience. It is also apparent that the girl with a high cognitive measure illustrated a high stability of her views, which had not yet been disturbed by the necessity for assuming any classroom responsibilities. The principal differences to note, that might be attributed to a cognitive ability to register intensity of predilection, are in the relative magnitudes of the correlation coefficients.

TABLE 4

SUMMARY OF CORRELATIONS OF ARRAYS WITH FACTORS AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR TWO INDIVIDUALS[1]

Subject Serial: 8008	Summary of Correlations: Q-Sort Design II				
Event	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.3614	.1782	-.2129	-.3515	-.3416
II-2	.2079	.3317	.2970	.3564	.1485
Correlation differences	-.1535	.1535	.5099	.7079	.4901
Student t	-.87	.86	2.87**	4.32**	2.77**
Self-correlation II-1, II-2	.0644				
T-Score	1.070 (r = .7237)				
Subject Serial: 6041					
II-1	.6733	.5792	.2772	-.1287	-.7079
II-2	.7525	.5149	.1287	-.2327	-.7129
Correlation differences	.0792	-.0644	-.1485	-.1040	-.0050
Student t	1.45	-.95	-1.88	-1.2868	-.09
Self-correlation II-1, II-2	.8218				
T-Score	2.498 (r = .907)				

**$p < .01$

[1] Data which are presented in this table are a routine production for computer program SUMCA.

Consideration of the Importance of the Single Case

In contrast to the ambiguities that may arise from consideration of the summary results applying to a group, by any device the reporter may develop, the nature of results that can be expected from study of affective behaviors by Q-methodology becomes clear when attention is centered about the individual case. It is unfortunate that the importance of the individual case becomes submerged in the volume of data relating to the group. The basic unit of consideration in the whole area of affective behavior, by Q-methodology, involves a single person's self-referent statements or notions made in relation to interactional situations. In abstract terms the basic element involves person X, in social conditions Y, and acting under certain mediating circumstances or instructions Z. The analysis of a single performance, and considered in terms of the instant position of the person with respect to his progress toward attaining a goal, such as qualifying for a teaching credential, becomes of great value for the person himself and for counseling.

Just as it would be impossible to present a historical record of a professional aptitude test by single performances, in the same way it would be impracticable to present the historical record of the single performances on Q-sorts obtained in this study. It may be that the importance of the single case analysis for instruction and counseling may seem to be subordinated in this study to consideration of the group analyses.

Results in Terms of Groups

Consideration of Group Changes in Terms of the Hypotheses

The selection of eight groups of experimental persons, each a relatively homogeneous assembly, constituted a variate design in the following sense. The selection of groups extended from those persons with comparatively no experience in teaching, that is, group X_6, to those persons with extensive teaching experience, such as found in groups X_3 and X_4. X_6 was the group which consisted mainly of juniors taking their first course in education. Groups X_3 and X_4 were the master teachers. In between these extremes there were elementary student teachers, secondary student teachers, and project teachers, all working for credentials under the California system. It was an expectation that the interaction of the homogeneous groups with the public school situation, each with certain common goals and problems placed before them, would bring about a degree of group commonality of attitude that would be assessable by a suitable probe. It also was an expectation that group changes would be similarly observed.

In order to obtain summary statements bearing on matters relating to groups the concept of the group-person, or modal-person, was developed in Chapter IV. The accumulated performances of individuals in an identifiable group were combined, with equal weighting given for each individual, and summing to gain a gross total score for each statement of the Q-sort. The totals gained by each statement were rank ordered, and a resultant composite array was derived thereby, which represent what the group would render as if it were one person. This might be considered a kind of description of a modal-personality. The derived modal-group-array was analyzed to give a distribution matrix, a score matrix, an analysis of variance, a homogeneity of variance test, and a table of correlations of the score matrix with the empirically derived factors appropriate for the Q-sort design. When an identifiable group has performed twice during a testing period, such as on Q-sort design II, the performance can be compared in terms of changes in the correlations with each of the factors, using Hotelling's test.

The analysis of group results, when using the modal array method, permits the presentation of data in the same format generally as was done for individuals. The statistical guidelines that were established for review of individual performances also apply in general to a review of group results. Additionally there is given an analysis of variance of the modal array in a somewhat abbreviated form. The analysis of variance is useful to provide collateral evidence, though it is somewhat of an a priori character. That is, the significance that can be attached to the results from consideration of the analysis depends on the hypothetical structure of the Q-sort design, and not on any empirical relationship.

Statistical guidelines by which to determine significances in the analysis of variance results are as follows:

Source of Variation		df	F ratio .05	F ratio .01
Between Groups:	BETW	5	2.41	3.43
A Effect :	A/EFF	1	4.04	7.19
B Effect :	B/EFF	2	3.19	5.08
A x B :	INTER	2	3.19	5.08

The above guidelines also apply to evaluation of individual Q-sort analyses.

Hypothesis 2.3 is considered to be the most important statement of all the psychological aspects of the study, and the results obtained in this study are similarly regarded. It was expected that changes in novice groups, identified as groups X_1, X_2, X_5, X_6, X_7, and X_8, as revealed through comparisons of two performances of these groups on Q-sort design II, would be in the direction of a deepening of appreciation for statements bearing on teaching and learning. In terms of the Q-sort design it was expected that there would be a statistically significant change for appreciation of level "f" of the factorial design, in the factor of school operation. Q-sort design II was expected to have the sensitivity to reveal this kind of change, both for individuals and for groups. The nature and degree of the anticipated change was rationalized as having a direct relation to the extent of responsibility that each novice group and individual had been assigned in the classroom.

Certain research hypotheses were further represented in the following paradigm:

$$H_1 \quad : X_5 > X_2, X_1 \qquad \text{(1963 series)}$$

$$H_2 \quad : X_8 > X_7 > X_6 \qquad \text{(1964 series)}$$

In words, H_1 predicts that the project teachers in group X_5 would manifest confirmation of the hypothesis 2.3 to a degree significantly greater than either student teacher group X_2 or X_1. Hypothesis H_2 predicts that there would be a transitive separation between the groups, with the project teachers in X_8 confirming the hypothesis 2.3 to a greater degree of significance than secondary student teachers in group X_7, and that both these groups being superior to the most novice group of all, X_6, which were the juniors taking their first course in education.

A summary statement is presented to illustrate the rather dramatic confirmation of hypothesis 2.3, and in light of the more specific research hypothesis H_1 and H_2, Table 5 displays such data, abstracted from the analyses of groups in Tables 6 through 13. Table 5 lists "Student t" statistic that each group gained in terms of the statistical significance of the correlation change with each of the five factors for design II.

The Student t data for master teacher groups, X_3 and X_4, were not mingled with the data for novice groups in Table 5. It is interesting to extrapolate interpretations of the data, with the results of these two groups included, in the following sense: in the continuum from a status of no responsibility in the classroom to a status of experienced autonomy, the matter would appear to go a kind of full circle, in terms of change of attitude toward teaching. That is, the most novice groups and experienced teachers would appear to present the least change; intermediate groups manifest change in proportion to the responsibility which each had been assigned.

TABLE 5

DISPLAYING STUDENT T STATISTIC FOR EXPERIMENTAL GROUPS X_5, X_2 AND X_1 (1963 SERIES) AND X_8, X_7, X_6 (1964 SERIES) FOR CHANGES IN CORRELATIONS WITH FACTORS, DESIGN II

Experimental Group	Summary of "Student t" Statistics in Each Factor				
1963 Series[1]	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
X_1 Elementary Student Teachers	1.84	1.72	-1.39	-.74	-1.88
X_2 Secondary Student Teachers	-2.67**	-.92	.82	.17	.12
X_5 Beginning (Project) Teachers	.00	1.28	3.13**	2.26*	-.19
1964 Series[2]					
X_6 Junior Students USC	.15	-1.11	-1.88	-.39	.09
X_7 Secondary Student Teachers	-.33	2.68**	3.65**	3.51**	2.18*
X_8 Beginning (Project) Teachers	-.92	3.51**	5.53**	4.29**	2.50*

*$p < .05$; **$p < .01$

[1] These data confirm $H_1 : X_5 > X_2, X_1$

[2] These data confirm $H_2 : X_8 > X_7 > X_6$

TABLE 6

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_1: ELEMENTARY STUDENT TEACHERS

(n = 23)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.5941	.6931	.8168	.7574	.4356
II-2	.6782	.7624	.7673	.7277	.3317
Correlation differences	.0841	.0693	-.0495	-.0297	-.1039
Student t	1.84	1.72	-1.39	-.74	-1.88
Correlation II-1, II-2	.90099				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	11.07	3.62**	13.29	4.71**
WITH	3.06		2.82	
A/EFF	.30	.10	3.63	1.29
B/EFF	22.39	7.33**	21.56	7.63**
INTER	5.13	1.68	9.85	3.49**

**$p < .01$

TABLE 7

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST FOR GROUP X_2: SECONDARY STUDENT TEACHERS

(n = 37)

	Summary of Correlations				
Event	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.8168	.7673	.7178	.6980	.3366
II-2	.6832	.7178	.7624	.7079	.3465
Correlation differences	-.1336	-.0495	.0446	.0099	.0099
Student t	-2.67**	-.92	.82	.17	.12
Correlation II-1, II-2	.8069				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	8.67	2.62*	11.02	3.60**
WITH	3.31		3.06	
A/EFF	8.96	2.71	2.67	.87
B/EFF	11.17	3.38*	21.56	7.04**
INTER	6.02	1.82	4.67	1.52

*p < .05; **p < .01

TABLE 8

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_3: MASTER ELEMENTARY TEACHERS

(n = 23)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.6485	.7277	.7970	.8317	.5396
II-2	.7178	.7871	.8515	.8663	.4554
Correlation differences	.0693	.0594	.0545	.0346	-.0842
Student t	1.733	1.68	1.82*	1.23	-1.75
Correlation II-1, II-2	.9158				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	8.09	2.40	14.79	5.72**
WITH	3.37		2.58	
A/EFF	.30	.09	4.74	1.84
B/EFF	16.22	4.82*	30.91	11.96**
INTER	3.85	1.14	3.69	1.43

*p < .05; **p < .01

TABLE 9

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST FOR GROUP X_4: MASTER SECONDARY TEACHERS
(n = 27)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.5891	.6485	.6733	.7624	.5446
II-2	.5941	.6040	.6782	.7228	.5446
Correlation differences	-.0050	.0445	-.0049	.0396	.0000
Student t	-.10	.86	-.11	1.01	.00
Correlation II-1, II-2	.9059				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	5.60	1.54	6.04	1.69
WITH	3.63		3.58	
A/EFF	1.19	.33	.67	.19
B/EFF	10.67	2.94	12.72	3.55*
INTER	2.74	.76	2.06	.57

*p < .05; **p < .01

TABLE 10

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_5: BEGINNING ELEMENTARY TEACHERS (n = 25)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.5842	.6436	.7871	.7574	.5000
II-2	.5842	.6980	.8762	.8317	.4901
Correlation differences	.0000	.0544	.0891	.0743	-.0099
Student t	.00	1.28	3.13**	2.26*	-.19
Correlation II-1, II-2	.9110				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	8.27	2.47	14.22	5.22**
WITH	3.35		2.73	
A/EFF	.30	.09	.30	.11
B/EFF	16.06	4.80*	31.72	11.63**
INTER	4.46	1.33	3.69	1.35

*p < .05; **p < .01

TABLE 11

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_6: PRE-STUDENT TEACHING GROUP

(n = 43)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.8317	.8218	.5545	.0594	-.4851
II-2	.8366	.7822	.4554	.0347	-.4802
Correlation differences	.0050	-.0396	-.0990	-.0248	.0050
Student t	.15	-1.1069	-1.8751	-.39	.09
Correlation II-1, II-2	.9860				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	19.02	8.54**	16.76	6.80**
WITH	2.23		2.46	
A/EFF	62.30	27.98**	54.00	21.92**
B/EFF	10.72	4.81*	8.67	3.52
INTER	5.69	2.55	6.22	2.53

*p < .05; **p < .01

TABLE 12

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_7: SECONDARY STUDENT TEACHERS

(n = 54)

Event	Summary of Correlations				
	F1 PER	F2 PER LT	F3 LT	F4 AUT LT	F5 AUT
II-1	.8663	.7723	.4406	.0545	-.4653
II-2	.8564	.8614	.6188	.2574	-.3416
Correlation differences	-.0099	.0891	.1782	.2030	.1238
Student t	-.3269	2.6849**	2.6525**	3.5050**	2.1758*
Correlation II-1, II-2	.8911				

Analysis of Variance:	II-1		II-2	
	Mean Square	F Ratio	Mean Square	F Ratio
BETW	15.64	6.07**	12.76	4.43**
WITH	2.58		2.88	
A/EFF	58.07	22.52**	39.19	13.61**
B/EFF	2.67	1.03	8.67	3.01
INTER	7.41	2.87	3.63	1.26

*p < .05; **p < .01

TABLE 13

COMPARISON OF CORRELATIONS WITH 5 FACTORS OF DESIGN II AND ANALYSIS OF DIFFERENCES BY HOTELLING t TEST, FOR GROUP X_8: BEGINNING TEACHERS (n = 46)

Event	Summary of Correlations F1 PER	 F2 PER LT	 F3 LT	 F4 AUT LT	 F5 AUT
II-1	.7525	.6931	.4010	.1040	-.3812
II-2	.7079	.8366	.6733	.3713	-.2129
Correlation differences	-.0446	.1436	.2723	.2673	.1683
Student t	-.9177	3.5051**	5.5275**	4.2882**	2.4982*
Correlation II-1, II-2	.8564				

Analysis of Variance:	II-1 Mean Square	 F Ratio	II-2 Mean Square	 F Ratio
BETW	15.64	6.07**	12.76	4.43**
WITH	2.58		2.88	
A/EFF	58.07	22.52**	39.19	13.61**
B/EFF	2.67	1.03	8.67	3.01
INTER	7.41	2.87	3.63	1.26

*p < .05; **p < .01

Consideration of Group Behavioral Status in Terms of the Hypotheses

The method of analysis by comparing changes correlations with factors, that is, by comparison of correlations of five factors with performances of design II on two occasions, by Hotelling t test, has been illustrated in Tables 5 through 13. The status of a preference, at the occasion of any one performance, can be determined by selection of the highest valued correlation in the displayed spectrum of correlations with factors. In this way one gains an appreciation of the relative emphasis of the preference in this manner, of the modal person representing the group. One also gains evidence in corroboration, from consideration of the corresponding analysis of variance of the performance of the modal person.

The above described method of determination of status of an individual or group has worked well for design II, where there is a relatively simple factorial structure. That is, a display of correlations indicating the relative predilection for the philosophical aspects of teaching philosophy, coupled with a degree of appreciation for the statements bearing on teaching and learning in the classroom, gives an intuitive picture that is easily interpreted. In the case of a more complicated factorial structure, such as in the case of design I, and where the matter of change is not under study, other methods of analysis may be preferable. Once the factorial design has been substantiated, that is, when the a priori structure has been determined to hold within a given population of subjects, then direct interpretations from analysis of variance of a performance may be possible. It may be empirically determined that elements of the factorial design are relatively simple, such as in the 1963 edition of design I, where the emphasis by persons and groups was largely in favor of the academic aspects of education over the social and vocational aspects. This result may have been a matter of the nature of the semantics involved in making up statements for the Q-sort. In the 1964 edition of design I, it was possible to empirically identify the academic and social aspects by factor analysis. A factor would be considered identified if there were sufficient numbers of experimental persons identifying with the cluster of persons expressing a predilection of a particular kind. If only one, or only a few, persons set forth a particular predilection it cannot be said the factor is empirically established, except as a possibility.

In both the 1963 or 1964 editions of design I there was sufficient information obtained from factor analysis to believe that there would be representatives found setting forth a predilection for parts of the a priori structure, thus lending some measure of confidence to an analysis of variance of a performance. In the 1964 edition of design I the increased complexity of the empirically determined structure made it less desirable to make an analysis by the method of correlations with empirically determined factors.

Empirically determined factors for design I were numerically defined for both the 1963 and 1964 editions in the previous chapter, and are useful when they are used to correlate with performances and when they are interpreted in light of other evidence available.

The development of the analysis of variance approach in consideration of group performances, for either design I or design II, begins with the assembly of the individual score matrix column totals, taken from the computer output from individual performances, such as illustrated in Figure 16. In a certain sense each set of column totals can be interpreted as a replication of several experiments in a factorial design, and by considering the contributions of all persons within the group being analyzed. From the grand sum of each set of column sums, an estimate can be made of the group's predilection, by arranging the data in the order of the factorial design. This matter is illustrated in Tables 14 through 19.

Analysis of variance procedure for group performances, and as illustrated in Tables 14 through 19 in analysis of group performance on design I, is accomplished by means of computer program titled ANVAR. The program includes a homogeneity of variance test, and an estimate of chi square, together with computation of theoretical frequencies in the factorial design, by means of which to determine matters that contribute to the accuracy of analysis. The chi square estimate gives useful information by which to interpret significant interaction, which is indicated in Tables 17, 18 and 19.

Interpretation of results presented in Tables 14 through 19 is given in brief form in the footnote to each table. The usual procedure for interpreting results in an analysis of variance involves, first, a search for the significant differences in the means. A necessary prelude to such a search is the determination that there exists a homogeneity of variance. This was found to be the case in each set of data, as a feature of the computer program ANVAR, the format of output of which is substantially the same as presented in the above listed tables. The analysis of variance gives the mean square within groups, abbreviated to WITH, which provides the basic information for computing the standard of differences between means. The significant F-ratios give cues as to where to look for significant differences of means.

In particular, in searching for significant differences in the means in Tables 14 through 19, the differences in A/EFF, that is, between PER and AUT, are easiest to interpret. All groups except X_3, the beginning elementary teachers in the 1963 series, clearly show a preference for PER over AUT, that is, for the permissive aspects of teaching in preference to the authoritarian aspects.

There was some a priori expectation that the academic aspects of education would be preferred to the social and vocational aspects. The B/EFF, which includes these levels in the factorial design, is significant for all groups of experimental persons, except X_6 and X_7, where the significance is in question. A guideline for comparison of means in the B/EFF is one chosen similar to that of Dunnett's t statistic (89:89). Using the given mean square within groups, abbreviated WITH, as an error estimate, the statistic of standard error of difference between means is computed using the relationship given by Guilford (35:264). An appropriate $t_{.01}$ for consideration of the difference in means in B/EFF is obtained by an entry into tables of t, with an appropriate number of degrees of freedom applying. The result is found to be in the neighborhood of 2.6, which is a convenient general estimate for the data under study. This value of t yields a gross measure of difference of means by which a determination of significance is made. For the groups under study, the following tabulation of differences is a convenient guideline:

Group	Difference in Means in B/EFF for significance
X_1	4.2
X_2	4.5
X_3	3.6
X_6	2.8
X_7	3.2
X_8	3.5

TABLE 14

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_1:
ELEMENTARY STUDENT TEACHERS, ON DESIGN I (1963)
(n = 27)

Recapitulation of score sums in cells, levels, and effects, according to factorial design:

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF: Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	1432	1239	2671	49.46
Social aspects	SOC	1212	1178	2390	44.26
Vocational aspects	VOC	1128	1101	2229	41.28
	Sums	3772	3518		
	Means	46.57	43.43		

Analysis of Variance:	SS	df	Mean Square	F Ratios	
TOTAL	8163.96	161			
BETW	2580.55	5	516.11	14.42	p <.01
WITH	5583.41	156	35.79		
A/EFF	420.50	1	420.50	11.75	p <.01
B/EFF	1779.72	2	889.86	24.86	p <.01
INTER	380.33	2	190.17	5.31	

Brief interpretation:

AC > SOC, VOC; PER > AUT

TABLE 15

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_2: SECONDARY STUDENT TEACHERS, ON DESIGN I (1963) (n = 35)

Recapitulation of score sums in cells, levels, and effects, according to factorial design:

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF:			
		Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	1763	1674	3437	49.10
Social aspects	SOC	1623	1465	3088	44.11
Vocational aspects	VOC	1524	1401	2925	41.79
	Sums	4910	4540		
	Means	46.76	43.24		

Analysis of Variance:

Source of variation	Sum Squares	df	Mean Square	F Ratios	
TOTAL	13294.00	209			
BETW	2640.74	5	528.15	10.11	$p < .01$
WITH	10653.26	204	52.22		
A/EFF	651.90	1	651.90	12.48	$p < .01$
B/EFF	1954.83	2	977.41	18.72	$p < .01$
INTER	34.01	2	17.00	.33	

Brief interpretation:

AC > SOC, VOC; PER > AUT

TABLE 16

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_3: BEGINNING ELEMENTARY TEACHERS, ON DESIGN I (1963)

(n = 35)

Recapitulation of score sums in cells, levels, and effects, according to factorial design:

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF:			
		Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	1755	1696	3451	49.30
Social aspects	SOC	1555	1593	3148	44.97
Vocational aspects	VOC	1377	1474	2851	40.73
	Sums	4687	4763		
	Means	44.64	45.36		

Analysis of Variance:

Source of variation	Sum Squares	df	Mean Square	F ratios	
TOTAL	9402.00	209			
BETW	2776.29	5	555.26	17.10	p <.01
WITH	6625.71	204	32.48		
A/EFF	27.50	1	27.50	.85	
B/EFF	2571.51	2	1285.76	39.59	p <.01
INTER	177.27	2	88.63	2.73	

Brief interpretation:

AC > SOC > VOC

TABLE 17

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_6: PRE-STUDENT TEACHING GROUP, ON DESIGN I (1964)

(n = 56)

Recapitulation of score sums in cells, levels, and main effects, arranged according to factorial design:

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF:			
		Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	2969 (2772)	2204 (2401)	5173	46.10
Social aspects	SOC	2720 (2714)	2345 (2351)	5065	45.21
Vocational aspects	VOC	2411 (2615)	2469 (2265)	4880	43.57
	Sums	8100	7018		
	Means	48.21	41.77		

Analysis of Variance

Source of variation	Sum Squares	df	Mean Square	F ratios	
TOTAL	17809.99	335			
BETW	6902.92	5	1380.54	41.77	$p < .01$
WITH	10907.07	330	33.05		
A/EFF	3484.30	1	3484.30	105.42	$p < .01$
B/EFF	392.08	2	196.04	5.93	$p < .01$
INTER	3026.54	2	1513.27	45.78	$p < .01$

Brief interpretation:

PER > AUT; with significant INTER. Chi square = 64.48.

Theoretical frequencies indicated in parentheses.

TABLE 18

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_7: SECONDARY STUDENT TEACHERS, ON DESIGN I (1964) (n = 53)

Recapitulation of score sums in cells, levels, and effects, according to factorial design:

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF:			
		Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	2700 (2593)	2159 (2266)	4859	45.84
Social aspects	SOC	2688 (2583)	2152 (2257)	4840	45.66
Vocational aspects	VOC	2249 (2461)	2362 (2150)	4611	43.50
	Sums	7637	6673		
	Means	48.03	41.97		

Analysis of Variance:

Source of variation	Sum Squares	df	Mean Square	F ratios	
TOTAL	18490.00	317			
BETW	5951.40	5	1190.28	29.62	p <.01
WITH	12538.60	312	40.19		
A/EFF	2922.31	1	2922.31	72.72	p <.01
B/EFF	359.45	2	179.73	4.47	p <.01
INTER	2669.63	2	1334.81	33.21	p <.01

Brief interpretation:

PER > AUT; with significant INTER. Chi square = 57.68.

Theoretical frequencies indicated in parentheses.

TABLE 19

ANALYSIS OF VARIANCE RESULTS FOR EXPERIMENTAL GROUP X_8: BEGINNING ELEMENTARY TEACHERS, ON DESIGN I (1964)

(n = 42)

Recapitulation of score sums in cells, levels, and main effects, according to factorial design.

Levels of school operations, B/EFF:		Levels of educational philosophy, A/EFF: Permissive PER	Authoritarian AUT	Sums	Means
Academic aspects	AC	2192 (2041)	1716 (1868)	3908	46.52
Social aspects	SOC	2060 (2041)	1868 (1877)	3928	46.76
Vocational aspects	VOC	1669 (1830)	1835 (1674)	3504	41.71
	Sums	5921	5419		
	Means	46.99	42.80		

Analysis of Variance:

Source of variation	Sum Squares	df	Mean Square	F ratios	
TOTAL	14198.00	251			
BETW	4826.90	5	965.38	25.34	$p < .01$
WITH	9371.10	246	38.09		
A/EFF	1000.02	1	1000.02	26.25	$p < .01$
B/EFF	1362.67	2	681.33	17.89	$p < .01$
INTER	2464.22	2	1232.11	32.34	$p < .01$

Brief interpretation:

PER > AUT; AC, SOC > VOC; with significant INTER.

Chi square = 53.11.

Theoretical frequencies indicated in parentheses.

Tables 17, 18 and 19 refer to significant interaction, which is observed in the analysis of variance results. A rational explanation of the matter can be obtained by comparing the theoretical frequencies in the 2 x 3 factorial design, with the observed frequencies, after the manner of a chi square analysis. Where significant INTER is indicated the theoretical frequencies are also given in parentheses. The pattern of comparisons in the three tables points to a similar kind of interaction, that is, PER is related to AC, while AUT is related to VOC. There was no interaction in the 1963 edition of design I. Interaction may result from a feeling that strong leadership should be expressed in matters in which the experimental persons feel they have less responsibility. Interaction also results from inadequacies of statements in a Q-sort to maintain psychological balance in the a priori concept of the design, which is a difficult matter to engineer.

Consideration of the Importance of Group Results

Several matters of importance have been empirically determined, by analysis of group performances, which can be used as guidelines by which to assess future performances of similarly constituted groups, and to form a relative basis by which to assess individual performances. The matters determined may be considered to have been intuitively true and known all of the time. Many such conceptions persist in education, which may be alleged as being "self-evidently" true. It probably is the gradual analytical verification of such psychological matters, especially in the affective domain of behavior, that is beginning to separate the concept of teaching and learning from the status as an "art," toward the status as a "behavioral science."

The results that are of importance are summarized in the following paragraphs. The general nature of such results are found in the patterns of behavior that may be expected of person X, when placed in a social situation Y, and with certain responsibilities Z. X is an apprentice-teacher, Y is the classroom, and Z is the extent of teaching responsibility assigned, as a typical set of conditions. It is found quite definitely that, for the apprentice, the appreciation for statements bearing on teaching and learning gain in proportion to the extent of teaching responsibility assigned him. From this finding, the inference is made that "apperception" into the teaching act is made more acute, with the necessity for responsible action. Students who have no responsibility in a classroom, such as represented by experimental group X_6, register no change by the method of analysis used; whereas, persons immediately involved in responsibilities for teaching, such as represented by experimental groups X_3 and X_8, show very significant changes. This kind of result, determined from analysis of group performances, then serves to create a behavioral pattern by which to consider individual performances. Thus, knowing the status of a person X, who is an apprentice-teacher, in the course of obtaining a teaching credential, we would expect that a certain pattern of change of behavior would be manifest in two well separated performances on Q-sort design II.

One of the most remarkable changes in attitude, a matter that seems to be well substantiated from the results listed in tables, pertains to the shift, with experience, from a predominantly permissive point of view. The permissive point of view, that appears to be so strongly expressed by the apprentice in the beginning of his teaching experience, appears to shift toward a neutral or even to an authoritarian point of view, as his experience lengthens and somewhat proportional to the extent of his responsibilities in the classroom. The change can be rationalized on the basis that any new participant in an activity wants to be liked and accepted in the new environment; consequently his behavior will express the desire to please, to be liked, and to be accepted. The attitude changes as his experience and confidence become greater.

The importance of a variate design in an investigation is implied in the foregoing statements; that is, the differential changes occurring between identifiable groups give a necessary perspective as to the meaning of the differences. Consistent results, such as in the matter of interaction in analysis of variance, enable one to place the explanation more accurately, when a variate design is considered.

Recapitulation

Consideration of Summary Statements

It has been pointed out in the section devoted to consideration of group status that summary statements have some weaknesses in presenting a true status picture. In particular, the concept of "modal person" may have only a relative meaning under certain circumstances, such as when a group is considered, containing several stable diverse sub-groups. The concept of modal person has to be interpreted in the light of the known constituency of the group, and there is always the possibility that interesting facts will be "washed out" in the computation of this kind of "average." The uses of summary statements continue in psychological fields of investigation, for their convenience, and because they may reveal indications of trends and characteristics which would be hard to present otherwise. An example, pertaining to the above discussion, may be seen in the data presented in Table 9 concerning master secondary teachers. It would appear from the displayed data that master teachers in this group, X_4, were essentially neutral with respect to educational philosophy, and demonstrating significant appreciation of matters relating to teaching and learning. Their stability in their views is illustrated in the high correlation between events II-1 and II-2, which is .9059. Actually the constituency of the group was such that the effects of predilection of permissive and authoritarian types tended consistently to offset each other.

From the above discussion it may be gathered that any kind of summary statement must be viewed cautiously, and in the light of other evidence, when possible. Further, it may be adduced that the nature of testing instruments must be considered in light of the nature of the psychological phenomena that is under study. Design II of the Q-sort was developed for the assessment of changes in persons that occurred as a result of their teaching experience. The method of assessment of change that has been presented in Tables 5 through 13 appears to be effective and realistic. But, for the reasons that may be inferred from consideration of the case of secondary master teachers in Table 9, it would be desirable to have other information before making conclusions regarding group status from the same data as presented.

Design I of the Q-sort was designed to assess status with respect to academic, social, and vocational objectives of education, and it was hardly expected to be sensitive enough to assess changes of predilection in these areas. When it was determined that the factor structure of the theoretical design appeared to be fairly well substantiated by factor analysis, then summary statements in the form of analysis of variance appeared to be capable of presenting the group picture as well as could be expected. Such data are presented in the series of Tables 14 through 19, all presenting derived data from performances on design I.

Group results relating to preferences for the objectives of education, that is, for the academic, social, and vocational aspects, may lead one to believe that there was more confirmation of the permissive versus authoritarian philosophical preferences than in substantial indications of preferences in terms of objective. It would be understandable that university students would, by their association with academics through recent experience, feel that academic objectives were to be preferred. This seems to be the case in the 1963 edition of design I. The groups which had a real contact with the public school situation, in terms of a teaching responsibility, were the beginning teacher groups, X_5 and X_8. In terms of group performance on design I these two groups seem to have made the better effort. In view of the fact that the semantic nature of the statements in design I reflect more of the secondary school situation than of the elementary schools, the results are rather indicative that it is the real contact with the schools in terms of actual teaching that determines the genuineness of a preference. This seems to have been a characteristic of the beginning teachers, thus pointing up again the possibility that the basic influence on apprentice teachers is the necessity for assuming a responsibility. The beginning elementary teachers, X_8, indicated social objectives were relatively equal in importance to the academics.

Table 20 presents a recapitulation of analysis of variance results of the eight experimental groups, in their performances on Q-sorts, designs I, II-1, II-2, for the 1963 and 1964 series. This summary statement is quite abbreviated, and is to be viewed with appreciation of the previously stated cautions regarding summary statements. Substantiating data for analysis of variance results on events II-1 and II-2 are not furnished; such data are of the same form, however, as given in Tables 14 through 19. There are interesting changes to be noted in the certain groups between events II-1 and II-2, which confirm the results presented in another manner in Tables 6 through 13. This points up the complementary nature of the two methods of analysis used, one of empirical foundation, and the other of an a priori kind.

TABLE 20

RECAPITULATION OF ANALYSIS OF VARIANCE RESULTS OF EIGHT EXPERIMENTAL GROUPS IN PERFORMANCES ON Q-SORTS, DESIGNS I, II-1, AND II-2, FOR 1963, 1964

Experimental Group	Performances on Q-Sort Design		
	I	II-1	II-2
1963:			
X_1: Elementary student teachers (n about 27)	AC > SOC, VOC PER > AUT	LT > GS > GC	LT > GS > GC PER > AUT
X_2: Secondary student teachers (n about 38)	AC > SOC, VOC PER > AUT	LT > GC, GS PER > AUT	LT > GS GC PER > AUT
X_3: Master elementary teachers (n about 25)		LT > GS > GC	LT > GS > GC PER > AUT
X_4: Master secondary teachers (n about 36)		LT > GS, GC	LT > GS, GC
X_5: Elementary beginning teachers (n about 35)	AC > SOC > VOC	LT > GS > GC	LT > GS > GC
1964:			
X_6: Pre-student teaching group (n about 56)	PER > AUT	LT > GS > GC PER > AUT	LT > GS > GC PER > AUT
X_7: Secondary student teachers (n about 53)	PER > AUT	LT, GS > GC PER > AUT	LT > GS > GC PER > AUT
X_8: Elementary beginning teachers (n about 42)	AC, SOC > VOC PER > AUT	PER > AUT	LT > GS > GC PER > AUT

Total n about 312.

Hypotheses of Exploratory Interest

General Intent

It was the general intent to look beyond the immediate assessment of singular hypotheses that were stated in the first chapter. Additional exploratory effort was devoted to resolve interesting questions of miscellaneous nature, and the results of a few are given brief mention in this section. The subordination of these additional aspects was felt necessary in order that attention be directed to the most significant developments in the foregoing sections.

Communication Behavior as a Cognitive Matter

It is considered a necessary condition that communicating behaviors form a basis for adequate performance in affective matters. Confirmation of this consideration paves the way for exploration into methods for relating the cognitive and affective domains of behavior. The first step was to obtain a statistically significant multiple R, using cognitive measures obtained independently of this study as independent variables, and measures of information transmitting behavior as the dependent variable. Certain of the data for this analysis were obtained from events T_6, T_7, and T_8, listed in Table 6. T scores, in terms of "bits" of information transmitted by each experimental person, comprised the dependent variable, and were shown to have substantially a normal distribution. A professional aptitude test battery given to education majors furnished the independent cognitive measures. Multiple regression and correlation analysis of data for 90 persons from experimental groups X_6 and X_7 was accomplished by computer program, similar to that listed as BMDO3R (86:258-275). A significant multiple R of .57 ($p < .01$) was obtained. The most useful predictors of the T scores in the latter were English, Mathematics, and General Culture, in that order.

Thus it is felt established that T scores of communicating behavior, using information theory "bit" measure, are useful cognitive measures in their own right. The value of the T score is seen to extend further, because of its direct relation with the semantic content and theory of the Q-sort instrument.

Q-Methodology Applied to Prospective Teachers of Mathematics

It was felt that the procedures of Q-methodology, paralleling the study of affective behaviors in novice teachers in general, could be extended in principle to the study of the same behaviors in specific disciplines, such as mathematics. An experimental design of Q-sort, designated as design III, was developed to bear on the assessment of affective behaviors in prospective teachers of mathematics. The design is abstractly identical with Q-sort design II, and illustrates a theory of interaction of the so-called "discovery" method of teaching (92), and its logical counterpart, known as the "tell and do," method (28:1014). Q-sort statements in design III all have basic semantic content relating to the teaching of specific aspects of mathematics. Pilot studies with design III have yielded results very much of the same pattern of behavior as observed in design II.

Conforming Influence of Master Teachers

It was expected that self-correlations computed from two performances on design II by master teachers would indicate a more consistent predilection than would self-correlations of their corresponding student teachers, computed on the same design. By using a procedure which took correlations as convenient scores, testing for homogeneity, and making a z' transformation, it was possible to apply small sample theory to test this expectation. It was found that master teachers did indeed have a more stable view toward teaching than did their corresponding student teachers. The sample included 50 pairs, in elementary and secondary schools. By correlating the Q-sort performance of a master teacher with the corresponding performance of his student teacher it was possible to obtain two sets of correlations, one at the beginning of the semester and one at the end of the semester, and to compare means by small sample theory as above. The results indicate that master teachers had no conforming influence upon their corresponding student teachers.

Use of Rating Forms to Assess Teaching Types

An experiment with rating forms resulted in an interesting failure to support hypothesis. It was expected that coordinators of student teachers and master teachers would agree in general as to a choice of teaching type that a student teacher would exemplify. Based on definitions of the five factors in design II, certain forms were constructed for the two classes of observers of student teachers to rank in an order. That is, each rater was given five cards, each card describing briefly a teaching type, and with an instruction which called for the ranking of the five cards, from the type most characteristic of the student teacher each observed in common, to the last card indicating the least characteristic description. A contingency table listing the rankings of master teachers and university coordinators showed no relation. The finding may reinforce a skepticism as to the value of using rating sheets in the assessment of personality characteristics (63). Clearly this issue needs to be explored further, because so much of personnel management concerns assessment by rating sheet of personality characteristics, such as by supervisor of an employee or by a principal of a teacher.

Consistency of Predilection

It was of interest to determine if a consistency of predilection of individuals would be revealed when their performances on Q-sort designs I and II were compared. There was also an interest in the validity of the two Q-sort instruments to bear similarly on the same psychological matter, that is, of educational philosophy. The consistency was expected to be shown in a preference for either the permissive or authoritarian types, or in a neutrality. It was not practicable to correlate the performances directly, but a contingency table was formed which gave an acceptable conclusion in favor of the expectation. For experimental groups X_1, X_2, and X_5, a composite 5 x 5 contingency table was formed in the following manner. The correlations with factors in each person's performances on designs I and II-2 were rank-ordered and assigned numbers in succession from 1 to 5. Corresponding numbers were matched and entered in the form of a tally in the table. The concept of T, as a measure of transmitted information in the information theory model, can also be used as an indicator of relatedness, or association of shared information (2:50). The value of T in the case of 86 persons was .22923, which represents "bits" of information shared. Transformed into a correlation r, by a relationship given by Attneave (2:97), there is obtained r = .52. A chi square measures of significance of this estimate (2:63) compares approximately with chi square computed in the usual manner. The significant r was interpreted to mean that individuals rendering performances on designs I and II were consistent.

Statistical Questions Relating to Q-Methodology

There have been many discussions and some controversy regarding certain statistical aspects of Q-methodology. Block (6) and Wittenborn (89) each have thoroughly reviewed and investigated many of the technical and theoretical aspects of the methodology. It appears from review of reports, such as of Block and Wittenborn, that most of the research intent and method advocated by Stephenson has weathered the storm of criticism that has been directed against it, such as by Cronbach and Gleser (18). Much of the reluctance to implement Q-methodology appears to be due to an inaccurate understanding of the distinction between Q- and R-methodologies. The specific aspects of a statistical nature which seemed to have been relatively unresolved, and which had considerable bearing on developments in this study, relate to the use of a factorial structure to represent a theory, and to the extent of complexity that could be built in a factorial design. For example, Block (6:49) sees little virtue in a factorial design for his purposes, while Rinn (64) sees the development of a factorial design to represent a theory as a necessity.

It was believed logical to have a factorial design that could represent enough of a theory so as to develop significant information in testing operations. The significant information that was developed as a result of application of designs I and II would seem to confirm this expectation. Some precautions were taken to restrict the complexity of the theoretical design in the beginning, so that a typical experimental person's theoretical limitations for processing information would not be exceeded. This capacity, as a cognitive matter, had been determined with considerable confidence; for example, Garner (30) states that channel capacity, or limiting amount of discrimination, is quite stable, having a value of about 2.3 bits, which is equivalent to five stimulus variables. The channel capacity of individuals, as a cognitive matter, with respect to the Q-sort design II in particular, was studied by means of information gained from events T_6, T_7, and T_8, which are summarized in Table 1. It is felt that the obtained estimate of channel capacity, alias communicating behavior, has a direct relation to the adequacy of response to affective questions, such as brought up in Q-sorting, and deserves further theoretical study and experiment.

The statistically significant interactions in certain analysis of variance reports of group performances pose some further questions and implications for Q-sort statement construction. For designs I and II the main validating concern was for setting up sociological realism, and for semantic relevance of statements to parts of the theoretical design. It may be considered desirable to give special attention to psychological balance, which can be realized apparently by giving consideration to a uniformity of the psychological factor being represented in any given level in a factorial design.

Elements of "Action Research" Considered

It appears, after some little experimentation in the use of Q-methodology as an instructional device, that elements of action research can be introduced with good effect. Events T_6, T_7, and T_8 were scheduled ostensibly to familiarize participants with an unusual form of testing instrument. Measures of communicating behavior were obtained in terms of bits, which is the measure unit used in information theory. Among the several developments that were chosen to be considered in the course of these events, there was the test of the expectation that a revelation of certain details of the design would in fact give an inferential cue, or a tip-off, as to the nature and object of the testing sequence that was to follow. The interesting result seems to be that groups X_7 and X_8, which were in actual contact with the classroom on an intimate basis, apparently made use of the tip-off, either by conscious recall or unconsciously. Group X_6, which had only observational contact and which conceivably had gained little appreciation of a teaching responsibility, was not able to take advantage of the inferred "instruction."

The conclusion that can be drawn concerning a psychological kind of "press," or need for action, is that a concomitant element of sociological realism must actually be experienced before the appreciation for it can be expressed in other ways, such as in Q-sorting. There are other interesting facets of this most interesting variable, which might, for lack of a better description, be called a "necessity for assuming responsibility." Each little bit of information concerning it gives force to the process of "abduction" (77:7), as a way to explain phenomena and plan further tests.

In order to ensure a commonality of attention to the Q-sorting in the formally scheduled events, each person was instructed to sort statements in an order of their significance to him in his role as a teacher in the classroom situation in which he was serving, or was familiar. Action research is effective when other types of instruction for Q-sorting are given. For example, experimentation was carried on with pilot study groups, whereby they were first asked to sort statements which might characterize an authoritarian type, or how a teacher would act in a classroom situation calling for aggressive and forceful teaching behavior. Later, the same study groups were called upon to render a Q-sort characteristic of a permissive teacher. The two performances were correlated by participants, as a classroom exercise. The analysis of each correlation, and of the composite, yielded considerable insight as to how persons will pretend to act in a variety of "as if" circumstances. The teacher also gains a considerable respect for the flexibility of the Q-sort to reflect extremes in attitude.

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

Recapitulation

The specific object of this study was to assess affective behaviors in certain persons in education, including student teachers and their master teachers. The nature of the specific affective behaviors studied was contained in operational terms in the statements comprising the theoretical design of the testing instruments, known as Q-sorts. The research procedure follows that developed by Stephenson in his statement of Q-methodology (76). Two basic designs of instruments were used to investigate the following: (1) the assessment of the status of an attitude toward three objectives in education, that is, toward the academic, social, and vocational objectives to be found in a curriculum, and (2) the assessment of changes in attitude toward teaching, with particular consideration given to the assessment and identification of the psychological nature of the change occurring during a period of teaching apprenticeship.

The theoretical and abstract format of the designs of Q-sort instruments were similar, and conceived in factorial form: (1) one main effect provided for consideration of two levels of educational philosophy, that is, the permissive and authoritarian views, and (2) the second main effect in both instruments provided for consideration of aspects of school operations. In Q-sort design I the consideration of school operations bore on the academic, social, and vocational objectives in a curriculum. In Q-sort design II the consideration of school operations bore on a hierarchy of concepts, pertaining to learning and teaching, with the expectation that the experimental persons would gain a deeper apperception into the level most closely relating to specific classroom operations.

The Q-sorts were administered to the experimental persons with instructions that called for a response reflecting upon their personal traits and value system, and particularly with respect to the concept of their role as a teacher in the classroom situation in which they were serving. Since no attempt was made to control the events in the social situation in which the persons were serving, the study may be classed as a kind of status study, that is, an assessment of what naturally exists in a novice teacher situation. The wide use of correlational coefficients, and of factor arrays of teaching types, identifies the study as a correlation study. In execution of the procedure, the study may be classified as an eight-group pretest-posttest design. The experimental groups constituted a variate design, in order that a full range of educational experience be represented and observed, that is, from the most inexperienced novice to the master teacher.

Singular hypotheses, developed from general propositions of investigative interest, were arranged in a kind of sequential order for attention. In general terms, the hypotheses specified that the status and change of affective behaviors could be assessed, and these matters were subject to the prior successful accomplishment of methodological matters. The methodological matters pertained to a statement of an adequate theory relating to the problem, the construction and validation of Q-sort testing instruments, and the development of statistical procedures. Methodological developments were extensive, and designed with the objective that a system be developed that could be reproduced by educators in their own circumstances. It was on the singular hypotheses that the weight of investigative effort was brought to bear.

The study of affective behaviors has produced results in three categories, following the pattern of statement of the singular hypotheses: (1) individual results, (2) group results, and (3) methodological results. Neither the individual results nor the group results would have attained much meaning without the successful accomplishment of methodological matters preceding and accompanying the testing schedule. These methodological results included the unique manner of validation of Q-sort designs, in order to ensure the factorial fidelity of the testing instruments, and the construction of computer programs to process Q-sorts directly from the sort packs of statements. A system of computer programs enabled the analysis of data with no hand computations.

The nature of the results that can be expected from a study of affective behaviors, utilizing Q-methodology, is centered about the individual case. Stephenson, the founder of the Q-methodological approach to the study of psychological problems, advocates acceptance of the importance of the self-concept, or centrality of self, and the basing of psychological mensuration on matters pertaining to intra-individual significance of stimuli. Stephenson's basic unit of consideration involves a person's self-referent statements or notions, made in terms of the intra-individual significance and interactional variables and situation. The unit, or basic element, is described as person X, involved in social conditions Y, and with mediating circumstances Z. The primary data are self-descriptions, characterized by centrality of the subject. The foregoing brief statement of the research philosophy which motivated the procedure of the study provides a necessary basis for appreciation of the data pertaining to individuals particularly. All but a few of the persons in the study identified themselves to some extent with factors in design II in a statistically significant manner; that is, to such an extent that a rational explanation of the performance could be made. A statistical test of differences of correlations, from one administration to the next over the semester of observation, was adapted from a test by Hotelling and incorporated in a computer program, making it easy to determine the nature of the change.

In consideration of hypotheses relating to the homogeneous groups in the study, the concept of the modal personality was developed. A composite array for a group was obtained by summing all the scores on each statement in the Q-sort performances; the composite scores for each statement were rank-ordered and fitted in the quasi-normal distribution as for an individual Q-sort array. Thus the group has each member contribute his influence with equal weighting, and the result is an array for the group as if the group were a person. The correlations of the modal, or composite array, with empirically derived factor arrays of teaching types, afford a measure of the relation of the group to the types in the same manner as for individuals. The interaction of a homogeneous group, with certain goals and problems placed before it by society (e.g., school objectives and the nature of the school environment), would be expected to bring about a degree of group commonality which can be observed. The importance of summary results in education is considerable, and the modal personality concept affords a convenient way of providing such a summary. It was hypothesized that the nature of the change in the novice groups would be directly related to the extent of necessity for assuming responsibility in the classroom.

The hypothesis received substantial confirmation, pointing up the most noteworthy result of the study. That is, it was considered most significant that the extent of a necessity for assuming a responsibility seems to have accounted for the hypothesized differential, or change in attitude, in the experimental groups. This also points up the possibility that the real issues in the teaching function may well be in the behavioral aspects of assuming a teaching responsibility.

It appears that most of the singular hypotheses posed for investigation by Q-methodology received confirmation in terms of the statistical criteria that were applied. The increase in confidence in a methodology, and in a theory that is assessed by it, is on the basis of how many and how varied the different singular propositions that can be applied with favorable results. The weight of empirical evidence would appear to favor tentative acceptance of the general propositions that Q-methodology can be used effectively to assess affective behaviors in student teachers and others in the field of education.

Nature of the Effect of Necessity for Assuming Responsibility

General Considerations

It is noteworthy that the variations in the necessity for assuming a teaching responsibility seem to have accounted for the hypothesized differentials in the experimental groups in their performances on Q-sort design II. Beginning teachers indicated the most significant changes in direction of appreciation of learning and teaching statements, with some shift away from a purely permissive point of view. These teachers, serving on provisional credentials, assumed a teaching responsibility on what might be called a "sink or swim" basis. Their performance is in striking contrast to that of the most novice group, that of students taking their first course in education, who had no teaching responsibility. Possibly the greatest value in this study, from the point of view of the psychological variables involved, is in a gain in appreciation of the nature of the variable which might be called "the necessity for assuming responsibility." In the consideration of the variate design of experimental groups, the way of manipulation of the variable was not in making any modification of existing circumstances applying, but in observation of the differential effects of the variations of the circumstances that attended each.

The nature of comparison of the experimental groups is by way of consideration of the mediating circumstances, Z, in the XYZ paradigm. It was stated earlier in the procedure for investigation that the unit of behavior is man X, behaving in a social environment Y, under mediating circumstances Z. This paradigm is a basic consideration in the research design of this study, adapted from Stephenson's use of the concept (77:19). The variable, entering as it does into the definition of "Z" in the paradigm, would appear to be easily manipulated in any social situation found in education. In the current study the pattern and nature of a change in adapting to a teaching responsibility, which now can be objectively assessed by Q-methodology, may be the most important consideration that a teacher education institution may want to know about, in the course of carrying out its objective. The change in behavior that is reported was not systematically observed directly, that is, by watching the experimental persons in the classroom situation, but in terms of inferences from statistical analysis of two performances on a Q-sort. Observational data are necessary to augment and help explain test performances, however. There is a factor of unreliability introduced in using data that rest on the probe of investigating "X's behavior as observed by Y," that is, by rating procedures (63).

There is another source of information about the nature of the variable under discussion, and that relates to the indications of statistically significant interactions in certain analyses of variance reports. For example, the interactions reported in Tables 17, 18 and 19 are puzzling without a rational psychological explanation, that is, in behavioral terms. From a study of the patterns of this variation in these and other tables of group analysis of variance data, it appears that the people in an experimental group tend to express a predilection that would give them discretion in matters for which they have a responsibility. The nature of the variable seems to indicate that people approach their real life situations in an experimental manner, and want discretion to work out their adjustment problems. The change that can be observed in a person by a suitable probe of his behavior appears to be most apparent during the period of adjustment, of relative uncertainty, and of experimentation. Learning, as illustrated above, seems to follow the pattern of what mathematicians call "solving a problem by method of successive approximations" (92:26).

If it is considered desirable to have student teachers show a change in appreciation of statements bearing on teaching and learning, as a matter of statistical analysis of their Q-sort performances, it is conceivable that such a change would be encouraged by modification of the mediating circumstances in their teaching apprenticeship. That is, they could be permitted to teach for a period without supervision, as a privilege and incentive for completing a prior period of acceptable apprenticeship.

Implications

Implications of Results in Terms of Taxonomies of Educational Objectives

The distinguishing conceptual schema of cognitive and affective variables is a matter that psychologists have developed, and both are investigated largely by obtaining measures of individual differences. The cognitive variables are associated with measures of intelligence, aptitude, achievement or performance. Affective variables are measured by obtaining individual differences in attitudes, values, interests, appreciations, adjustment, temperament, and personality. The lack of significant success in applying the research strategy of individual differences to the affective domain of behavior has caused some speculation as to the possibilities for exploring that domain scientifically; for example, it is said that the noncognitive aspects of teaching are associated with the teacher's art, as distinguished from his craft (28:398).

The implementation of educational objectives, such as in the public schools, would appear to be part of an effort to bring about an early trend of the pupil to think and act in ways approved by his society, and less in terms of his elemental emotions. It is common to find expectations of this sort expressed to the effect that each person, in whom educational purposes are accomplished, will grow in knowledge and skills that give the ability to think effectively, to make wise decisions, and to take intelligent action.

The admitted inadequacy of teaching and appraisal techniques, for implementing and assessing those affective derivatives of educational objectives, may be considered to be a serious matter for education. For example, Coleman (91) points up a consequence of the problem in speaking of the impatience of the adolescent community with the imposed role of the passive learner. He says that, because of the liberation of the modern adolescent in society, a modification of the educational structure is required. This is attributed to the tendency of the adolescent society to focus its attention on those areas of activity in which it can assume responsibility and authority to act. The deterioration of interest in academic pursuits is an inevitable result, with increasing significance being given to the social games of dating, athletic contests, drama groups, and such extra-curricular activities, according to Coleman.

It may be presumed that an almost universal reliance on the monolithic character of the practice of mental testing solely for cognitive behaviors in school, after the tradition of R-methodology, has enforced and perpetuates practices in teaching that are detrimental to the development of teaching for development of the affective aspects of educational purposes. A tendency to teach for cognitive testing, with all the attendant consequences, may also be said to conspire to suppress the excitement of a pupil for exploring, creating, and experimenting in the academic disciplines, such as Polya (92) might desire in a teaching method.

The foregoing discussion sets some basis for more specific consideration of taxonomies of educational objectives, particularly of recent origin, such as those in which Bloom (8) and Krathwohl (54) had a part in formulating. The process of abstraction and discrimination of concepts illustrated in these two classifications, from basic substantive statements relating to educational objectives given by councils and commissions across the country, adheres consistently to a choice of behaviors that can be tested after the methodology based on the postulate of individual differences. Both classifications are tentative, and they thus may be considered as hypotheses which may be tested for agreement with empirical evidence; that is, whether the taxonomies are ordered to correspond to a real relation among relevant phenomena. It is hardly practicable for education to await such a process, except in areas of greatest uncertainty, such as in the domain of affective behaviors. The success of taxonomic theories will be established by fulfilled predictions derived from them, as Kaufmann says about theories in the social sciences (49:43). At the moment the success in the testing of the theory contained in the affective taxonomy is in question, principally it appears there is no adequate research strategy available for the task, unless it be that of Q.

Thurstone has said that it is natural to postulate that abilities, and their absence, as primary causes in the variations in performance on tasks (84:52). It is just as natural to postulate that variations in predilection behaviors are attributable to intra-individual significances attached to propositions representing variables interacting in a particular social situation. To say that something is "natural" probably means that it is self-evident, or so fundamental that it cannot be proved, such as the preliminary assumptions of geometry. Such postulations have been shown to lend themselves effectively and objectively to procedures after the manner of the scientific method, whether in psychology or in mathematics. A characteristic of the axiomatic method, as a basis for a deductive system, is that it consist of a very few independent axioms or postulates, from which deductions in the system can be made by specified rules of procedure.

The procedural characteristics of Q-methodology, as adapted to the study of the student-teacher problem, has brought to attention the implementation of the postulate of intra-individual significances, coupled with other assumptions about the nature of behavior and of typology. The probe of behavior has been one of "self-reflection of X," resulting in self-referent statements made in relation to an interactional situation. Such a self-description is operationally defined as a Q-sort array. It was a rationalization in the instant study that communicating behaviors, such as shown in a capability for relevant semantic stimulus identification, provides certain necessary conditions for an individual to make an adequate performance in the process of Q-sorting. It seems logical that this ability to communicate would be particularly applicable to the situation of teachers. This assumption would subsume a good deal of the preliminary part of the affective domain of behavior, as classified by Krathwohl et al. (54), which is obviously largely of a cognitive nature. Communicating behavior may be considered as both a matter of a person receiving and of responding, in a combination, according to that system of classification. A surplusage of definitions in that system does something to confuse the real issue, in the effort to proceed from consideration of the simple to the complex, in a hierarchical manner. Communicating behaviors are the tools of the teacher, and what he does with them are the real objects of investigation. The tools of behavior, thus described, are measurable by standards from the outside, such as by R-methodology. What is done with the tools of behavior may be considered as motivated by standards from inside, that is, from a subjective point of view, and R-methodology in assessment appears to be inadequate for the latter task.

It is within a further specific context of a social situation Y, and mediating circumstances Z, in the XYZ paradigm, that the system of Q-methodology operates. It is at this point that this research methodology, and strategy bearing on intra-individual differences, is sensitive to the expression of a hypothesized internalized value system that is truly affective in character. We agree with Stephenson, who says that behavior can be made amenable to reliable operations, and where the scientific method is at issue in objective procedures (76:25).

Theoretical developments in the field of education, such as presented above, and which have promise of utility, are most effectively implemented when coupled with practical methods. Educators are both theoreticians and implementers, but most are implementers in the classroom. The ease and economy with which results can be obtained from the system that has been presented, through the application and analysis of the given Q-sort testing instruments, coupled with the convenience of computer technology to perform all mathematical computations, does not preclude the necessity for the use of Q-methodology from understanding the nature of the results in light of the underlying theory.

The present study presents two important aspects of a solution to a type of educational problem: (1) a theoretical development of a system for exploring a specific area within the domain of affective behaviors, and (2) an offering of examples of testing instruments, together with necessary instructions and computer programs by which the educator can repeat the solution to the specific problem of novice teachers under his own circumstances.

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APPENDIX A

Q-SORT INSTRUMENTS

Q-SORT INSTRUMENTS

This appendix contains certain instructions applying to the Q-sort designs described in this study. Q-sort design II, 1964 edition, is given in full, with statements grouped in order of cell number and designation. Computer coding for each statement is indicated in the two-digit numbers in the left margin. Included in this appendix is an instruction given to participants for sorting. Two other figures are included also, one of which illustrates the hand computational form that may be used, and the other figure illustrating the format of individual Q-sort statements with a pile card.

FIGURE A-1

Q-SORTING INSTRUCTIONS

GENERAL

The pack of statements with which you are furnished contains descriptions of matters pertaining to education. You are invited to arrange the statements in a special type of rank order. Basically the rank order is an order of importance, or significance, to you in your role as a teacher in the classroom situation in which you are now serving. It is expected you will consider the statements with respect to what you know and feel about education, resulting in many acts of comparative judgment between statements given for review.

SORTING INSTRUCTIONS

First lay out the pile cards in numerical order, with #1 to your left. Next, read through the pack of statements quickly in order to get a general understanding of their content. As you read, divide the pack into 3 piles. The left pile should hold those statements for which you feel most agreement, the middle pile is for those statements for which you have neutral or undecided feelings, and the right pile is for those statements for which you feel least agreement.

After making the rough initial distribution of statements into 3 piles, proceed to separate the 3 piles into the final distribution. Each pile card indicates how many statements are to be assigned to it. The rank ordering of statements within the piles is of less importance than the rank ordering significance of the piles themselves, so do not spend too much time in adjusting the rank order of statements within the piles.

CONCLUDING

When you have finished sorting the cards into 9 piles, and in the frequency as indicated on the pile cards, assemble the statements into one pack again.

Pile #1 is put on top, other piles following in numerical sequence down to #9 which is on the bottom. Each pile card is put on top of its assigned statements. All statements should be upright in reading position. In a certain sense the statements should now appear in such an order that they represent your concept of their relative importance.

Carefully check the frequency distribution of statements in the piles. The count in each pile must be exact for computer processing. Fill out the IDENTIFICATION CARD, put it on top, and bind all together with a rubber band.

PRECEDING PAGE(S) MISSING

Q-SORT DESIGN II (1964 Series)

Cell 1/ad (Permissive/General Culture)

11 Society has the goal of bringing about conditions whereby citizens can adjust to changing circumstances, and adapt easily and intelligently to new problems.

21 We are living in an age in which attitudes of isolation are giving way to world-minded attitudes.

31 Man must question, for that is his nature.

41 A normal development of a person follows from a life in an environment that affords occasions for him to discover himself.

51 Man is working for an emancipation from external controls.

61 A government by the people is largely characterized by the opportunities it affords for impartial inquiry.

71 There is the view that the system of our time is the one that allows conflicting views to operate within an institution, provided that any view does not seek to subdue another.

81 Tolerant forms of dealing with dramatic individual differences in ability appear in a society that carries the hope of greatness in the shared aims of its people.

91 Much social behavior is expressed in resistance to pressures tending to a conformity, or which tend to mold or promote standardization of conduct.

Cell 2/ae (Permissive/General School Objectives)

12 Teaching may not be involved only with the growth in an ability for immediate recall by pupils, but also with the changes which will allow children to perform in the future.

22 Citizens expect the teacher and the school to serve as flexible resources, to be utilized by pupils in ways which seem most meaningful to the young.

32 The education ahead will shape new routes to adulthood as part and parcel of the community life, to give children a chance to grow in new and as yet uncharted ways.

42 The bridge between the school and its supporting society is not made by experts turning out courses of studies as directives.

52 A curriculum can hardly be expected to be a blueprint for the future, and accordingly, if a curriculum is to take advantage of unforeseen future developments it will include some license for alteration.

62 Schools have a responsibility for working with the ambitious student as well as with the apathetic one, going as far with each as possible in their education.

72 When parents are convinced that most matters, however complex, have only one side they can negate the school's best efforts to develop the skills of honest inquiry.

82 Imagination will prevent the school from being awkward and injudicious in business, art, and science, by keeping it close to concrete social existence.

92 The nature of education would be more appreciated by parents, as well as by the young, if the effort was made to describe learning as a process of discovery, and less in terms of the end results.

Cell 3/af (Permissive/Learning and Teaching Theory)

13 Gains for pupils follow from systematic procedures by the teacher in conducting class in a permissive, pupil-centered manner.

23 To keep up with the times in teaching action, one more than often finds he has to discard some comfortable routines and develop new ones.

33 Motivation for learning is accelerated when teacher controls the impulse to pose as an expert, when he raises thought provoking questions, and causes pupils to search out explanations.

43 Many pupils feel their intellectual growth and ability for making intelligent judgments are enhanced when they are given liberty for raising questions and talking about them.

53 In the classroom situation it may be readily felt that a student's real progress begins when he seeks answers to questions of his own volition.

63 The student ultimately teaches himself, though there are many possible aids, and the most effective of these is the live teacher because of his potential flexibility in response to the student's needs.

73 Appeals from the learner for help may not mean he really wants to be advised or told what to do, but that he wants to be understood, and to participate on equal terms in the intellectual issues under study.

83 Thinking behavior, indeed all teaching behavior for that matter, is an adventure; it essentially involves an element of chance, an experimental element.

93 The learning youngster prefers the new, the spontaneous, and the changing.

Cell 4/cd (Authoritarian/General Culture)

14 Established standards have a positive and stabilizing effect; where standards are cherished and fostered the behavior of people is influenced accordingly.

24 It seems possible to demoralize millions of people by making life easy for them, so they forget to use their brains.

34 A community has many reasons for wanting and enjoying the leadership of vigorous dedicated men and women in its social, political and economic life.

44 Some people can perform well only in a demanding world.

54 The average man finds it a comfort and a matter of emotional satisfaction to start from a firm basis, and of group solidarity.

64 We owe reverence to the great minds of the past, and present, and future.

74 Recent events suggest that it is inevitable that various degrees of external sanctions are required to maintain stability of the social order, and to ensure the harmony of its operation.

94 It takes trained and strong leadership to cope with and control the huge machinery of our society and its relentless growth and operation.

Cell 5/ce (Authoritarian/General School Objectives)

15 The right and privilege to an education at public expense is in recognition that the monuments of the human spirit do not stand untended, but are supported in each generation by the will of a given community.

25 The school is the natural setting for organizing efforts to identify early, and to direct the ablest young men and women into careers of leadership.

35 The evaluation of achievement in an objective manner is one of the school's obligations for judging the pupil, informing his parents, and for the school records.

45 It is in the national interest that public school systems be devoted towards the objective that everyone be trained up to the most for which each is capable.

55 The education of the young and the conduct of affairs of state are alike in a certain sense--they both are instruments for shaping the destiny of the nation.

65 Teacher is society's representative, and his training is premised from the standpoint that society wants the disciplined person for a special kind of cultural leadership.

75 While the public school implements the economic and social aims of the country in general, it is also recognized that educational aims have deep roots in the religious traditions of the people.

85 A school program sets up patterns of emphasis on matters that lead pupils to strive towards useful goals, and particularly towards dispelling the error of thinking that happiness means diversion and tranquility.

95 Whether teaching is spoken of as old-fashioned or modern, time-tested or experimental, the real issues are always the same--that is, the attainment of educational objectives structured about a core of fundamentals, such as the 3R's.

Cell 6/cf (Authoritarian/Learning and Teaching Theory)

16 The separate aspects of a teacher's job involve his stimulating the pupil's desire to learn, teaching him how to learn, and presenting the subject with authority.

26 Learned responses will be the responses students learn to give the purposeful teacher.

36 Out-of-bounds behaviors by pupils are often an occupational hazard for the teacher, and when occurring, constitutes a problem requiring his decisive and forceful action in correction.

46 "Perseverance" and "endurance" may seem to be mundane words to the teacher, but his doing of what those words call for is essential if he is to get his ideas across.

56 The technique of teaching a basic subject, such as algebra or arithmetic, is a matter of choosing specific behaviors in the subject that are desired, and in planning the best order and means for ensuring the formation of these behaviors.

66 Strong emphasis on performance usually returns definite gains in the classroom.

76 Student learning behavior is shaped by making reinforcements contingent upon his rendering certain responses.

86 When the end is initial learning of a few elementary responses, explicit and detailed directions will get the young learners into the habit of using their minds.

96 The classroom teacher who makes his position known in a direct and forceful manner usually gains respect, if not affection.

APPENDIX B

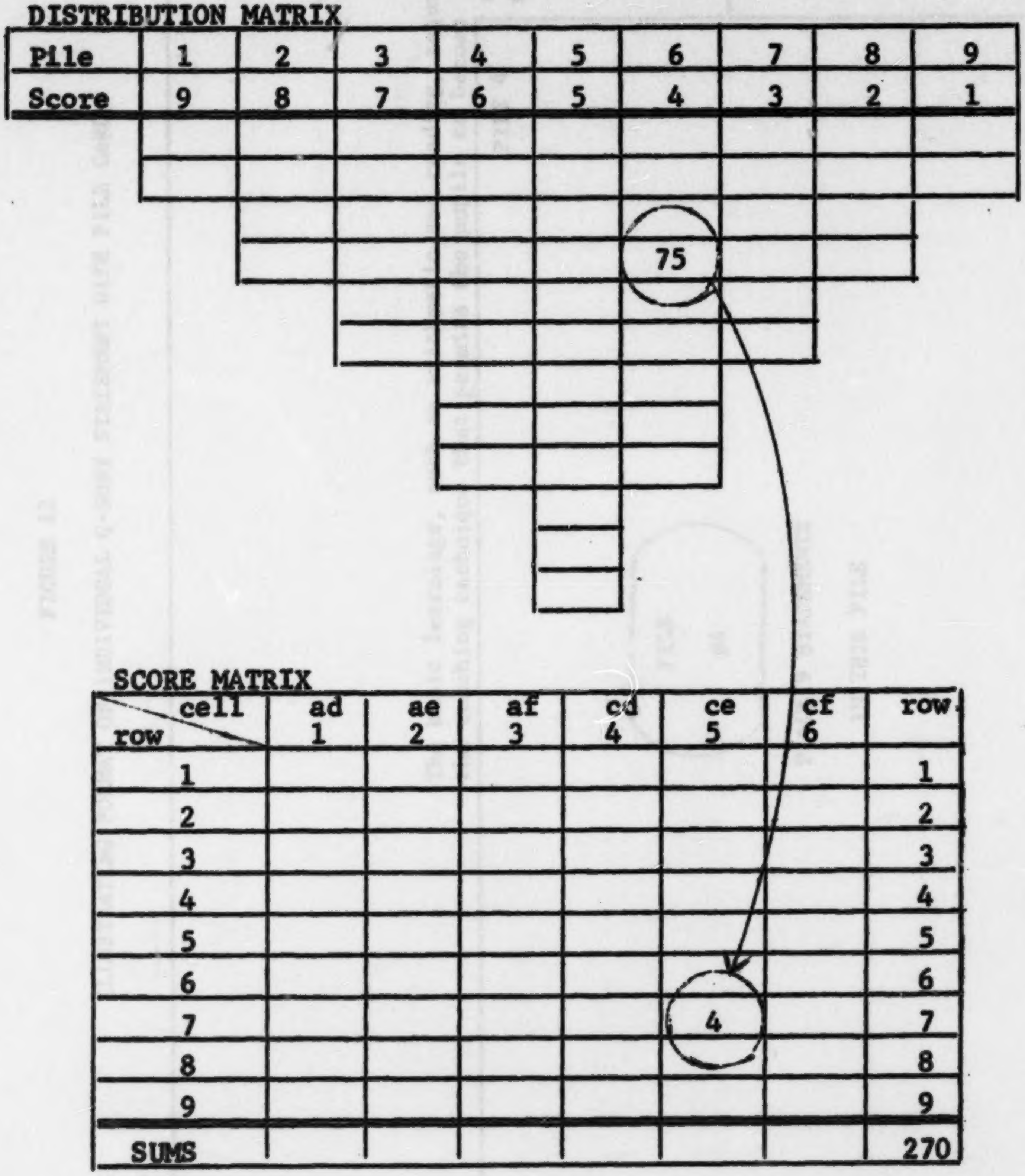
COMPUTER PROGRAM TABLE

```
C     PROGRAM TABLE FOR PROCESSING Q SORTS
C     FIRST CARD OF INPUT BEARS TWO NUMBERS WHICH DESIGNATE WHETHER
C     A DUPLICATE OUTPUT IS DESIRED, WHETHER CORRELATIONS WITH
C     FACTORS ARE TO BE COMPUTED, AND IDENTIFICATION OF SUBJECT, VIZ,
C     1 OR 0 IN COLUMN 1 INDICATES DUPLICATE PRINTED OUPUT OR NOT,
C     1 OR 0 IN COLUMN 2 INDICATES CORRELATION WITH FACTORS OR NOT,
C     IDENTICATION DATA OF SUBJECT IS WRITTEN IN NEXT 48 COLUMNS.
C
C     INPUT DATA DECK FOLLOWING ID CARD IS A STANDARD 54 CARD Q SORT
C     ARRANGED IN ACCORDANCE WITH FIXED DISTRIBUTION, WITH PILE CARDS
C     INTERVENING, FOLLOWED BY NUMERICAL DEFINITIONS OF FACTORS IF
C     COLUMN 2 HAS A 1 PUNCHED.
C
      DIMENSION CORI(5),F(9,6,5),FS(5),LOC(13,9),KOL(9,6),KSUM(6),
     1AV(6,4),S(9,6),SUMC(6)
  100 FORMAT(I2)
  199 FORMAT (23H  DISTRIBUTION MATRIX  //)
  209 FORMAT (16H  SCORE MATRIX  //)
  200 FORMAT(9I5)
  210 FORMAT(6I6)
  220 FORMAT(40X,I6)
  397 FORMAT (24H  ANALYSIS OF VARIANCE  //)
  398 FORMAT (6F6.0)
  399 FORMAT (I2)
  400 FORMAT (52H      VAR          SS          DF          MS          FR
  401 FORMAT (10H    TOTAL ,2F10.2)
  402 FORMAT (10H     BETW ,4F10.2)
  403 FORMAT (10H     WITH ,3F10.2)
  404 FORMAT (10H    A/EFF ,4F10.2)
  405 FORMAT (10H    B/EFF ,4F10.2)
  406 FORMAT (10H    INTER ,4F10.2)
  502 FORMAT (52HFACTORS           F1        F2        F3        F4        F5
  503 FORMAT (52H                  PER       PER/LT    LT        AU/LT     AU
  504 FORMAT (14HCORRELATIONS  ,5F8.4)
  597 FORMAT (51HSUMMARY OF CORRELATIONS OF ONE ARRAY WITH 5 FACTORS
  599 FORMAT (54F1.0)
  600 FORMAT (I1,I1,48H
  601 FORMAT (1H1)
  602 FORMAT (1H2)
    1 READ INPUT TAPE 5,600,KDUP,KFAC
      IF END OF FILE 99,2
    2 DO 10 I=1,13
      DO 10 J=1,9
      LOC(I,J)=0
   10 CONTINUE
   DO11 I=1,6
11 KSOM(I)=0
   READ INPUT TAPE 5,100,(LOC(I,1),I=1,3)
   READ INPUT TAPE 5,100,(LOC(I,2),I=1,5)
   READ INPUT TAPE 5,100,(LOC(I,3),I=1,7)
   READ INPUT TAPE 5,100,(LOC(I,4),I=1,10)
   READ INPUT TAPE 5,100,(LOC(I,5),I=1,13)
   READ INPUT TAPE 5,100,(LOC(I,6),I=1,10)
   READ INPUT TAPE 5,100,(LOC(I,7),I=1,7)
   READ INPUT TAPE 5,100,(LOC(I,8),I=1,5)
   READ INPUT TAPE 5,100,(LOC(I,9),I=1,3)
   DO 20 J=1,9
   DO 20 I=2,13
   IF(LOC(I,J))20,20,15
15 K= LOC(I,J)/10
   L= LOC(I,J)-K*10
   KOL(K,L) = 10-J
   KSUM(L) = KSUM(L) + KOL(K,L)
20 CONTINUE
   ISUM = 0
   DO30 I = 1,6
   ISUM = KSUM(I) + ISUM
30 CONTINUE
   KREP = 9
   SUMT = 0
   SUMTSQ = 0
   DO 60 J = 1,6
   SUMC(J) = 0
   DO 60 I = 1,KREP
   S(I,J) = KOL(I,J)
   SUMT = SUMT + S(I,J)
   SUMTSQ = SUMTSQ + S(I,J)**2
   SUMC(J) = SUMC(J) + S(I,J)
60 CONTINUE
   SUMCSQ = 0
   DO 61 J = 1,6
   SUMCSQ = SUMCSQ + SUMC(J)**2
61 CONTINUE
   REP = KREP
   TOTAL = SUMTSQ - SUMT**2/(6.*REP)
   BETW = SUMCSQ/REP - SUMT**2/(6.*REP)
   WITH = TOTAL - BETW
   ASQR=(SUMC(1)+SUMC(2)+SUMC(3))**2+(SUMC(4)+SUMC(5)+SUMC(6))**2
   BSQR=(SUMC(1)+SUMC(4))**2+(SUMC(2)+SUMC(5))**2+(SUMC(3)+
  1SUMC(6))**2
   AEFF = ASQR/(3.*REP) - SUMT**2/(6.*REP)
   BEFF = BSQR/(2.*REP) - SUMT**2/(6.*REP)
```

```
      ACTION=BETW-AEFF-BEFF
      AV(1,1)=TOTAL
      AV(2,1)=BETW
      AV(3,1)=WITH
      AV(4,1)=AEFF
      AV(5,1)=BEFF
      AV(6,1)=ACTION
      AV(1,2)=6.*REP-1.
      AV(2,2)=5.
      AV(3,2)=AV(1,2)-AV(2,2)
      AV(4,2)=1.
      AV(5,2)=2.
      AV(6,2)=2.
      AV(2,3)=AV(2,1)/AV(2,2)
      AV(3,3)=AV(3,1)/AV(3,2)
      AV(4,3)=AV(4,1)/AV(4,2)
      AV(5,3)=AV(5,1)/AV(5,2)
      AV(6,3)=AV(6,1)/AV(6,2)
      AV(2,4)=AV(2,3)/AV(3,3)
      AV(4,4)=AV(4,3)/AV(3,3)
      AV(5,4)=AV(5,3)/AV(3,3)
      AV(6,4)=AV(6,3)/AV(3,3)
      IF (KFAC) 71,71,69
   69 READ INPUT TAPE 5,599,(((F(I,J,K),J=1,6),I=1,9),K=1,5)
      DO 70 L = 1,5
      FS(L) = 0
      DO 70 I = 1,9
      DO 70 J = 1,6
      FS(L) = FS (L) + S(I,J) * F(I,J,L)
      CORI(L) = (FS(L) - 1350.)/202.
   70 CONTINUE
   71 PRINT 600,KDUP,KFAC
      PRINT 199
      DO 40 I=1,13
      PRINT 200,(LOC(I,J),J=1,9)
   40 CONTINUE
      PRINT 602
      PRINT 209
      DO 50 I=1,9
      PRINT 210,(KOL(I,J),J=1,6)
   50 CONTINUE
      PRINT 602
      PRINT 210,KSUM
      PRINT 220,ISUM
      PRINT 397
      PRINT 400
      PRINT 401,(AV(1,1)), (AV(1,2))
      PRINT 402,(AV(2,1)), (AV(2,2)), (AV(2,3)), (AV(2,4))
      PRINT 403,(AV(3,1)), (AV(3,2)), (AV(3,3))
      PRINT 404,(AV(4,1)), (AV(4,2)), (AV(4,3)), (AV(4,4))
      PRINT 405,(AV(5,1)), (AV(5,2)), (AV(5,3)), (AV(5,4))
      PRINT 406,(AV(6,1)), (AV(6,2)), (AV(6,3)), (AV(6,4))
      IF (KFAC) 73,73,72
   72 PRINT 602
      PRINT 597
      PRINT 502
      PRINT 503
      PRINT 504, (CORI(L), L = 1,5)
   73 IF (KDUP) 98,98,74
   74 PRINT 601
      PRINT 600,KDUP,KFAC
      PRINT 199
      DO 80 I=1,13
      PRINT 200,(LOC(I,J),J=1,9)
   80 CONTINUE
      PRINT 602
      PRINT 209
      DO 81 I=1,9
      PRINT 210,(KOL(I,J),J=1,6)
   81 CONTINUE
      PRINT 602
      PRINT 210,KSUM
      PRINT 220,ISUM
      PRINT 397
      PRINT 400
      PRINT 401,(AV(1,1)), (AV(1,2))
      PRINT 402,(AV(2,1)), (AV(2,2)), (AV(2,3)), (AV(2,4))
      PRINT 403,(AV(3,1)), (AV(3,2)), (AV(3,3))
      PRINT 404,(AV(4,1)), (AV(4,2)), (AV(4,3)), (AV(4,4))
      PRINT 405,(AV(5,1)), (AV(5,2)), (AV(5,3)), (AV(5,4))
      PRINT 406,(AV(6,1)), (AV(6,2)), (AV(6,3)), (AV(6,4))
      IF (KFAC) 98,98,75
   75 PRINT 602
      PRINT 597
      PRINT 502
      PRINT 503
      PRINT 504, (CORI(L), L = 1,5)
      PRINT 601
   98 GO TO 1
   99 STOP
```

FIGURE 14

ILLUSTRATING HAND COMPUTATIONAL FORMS FOR Q-SORT DESIGNS I AND II AND TYPICAL SCORING PROCEDURE FOR ONE STATEMENT



DISTRIBUTION MATRIX

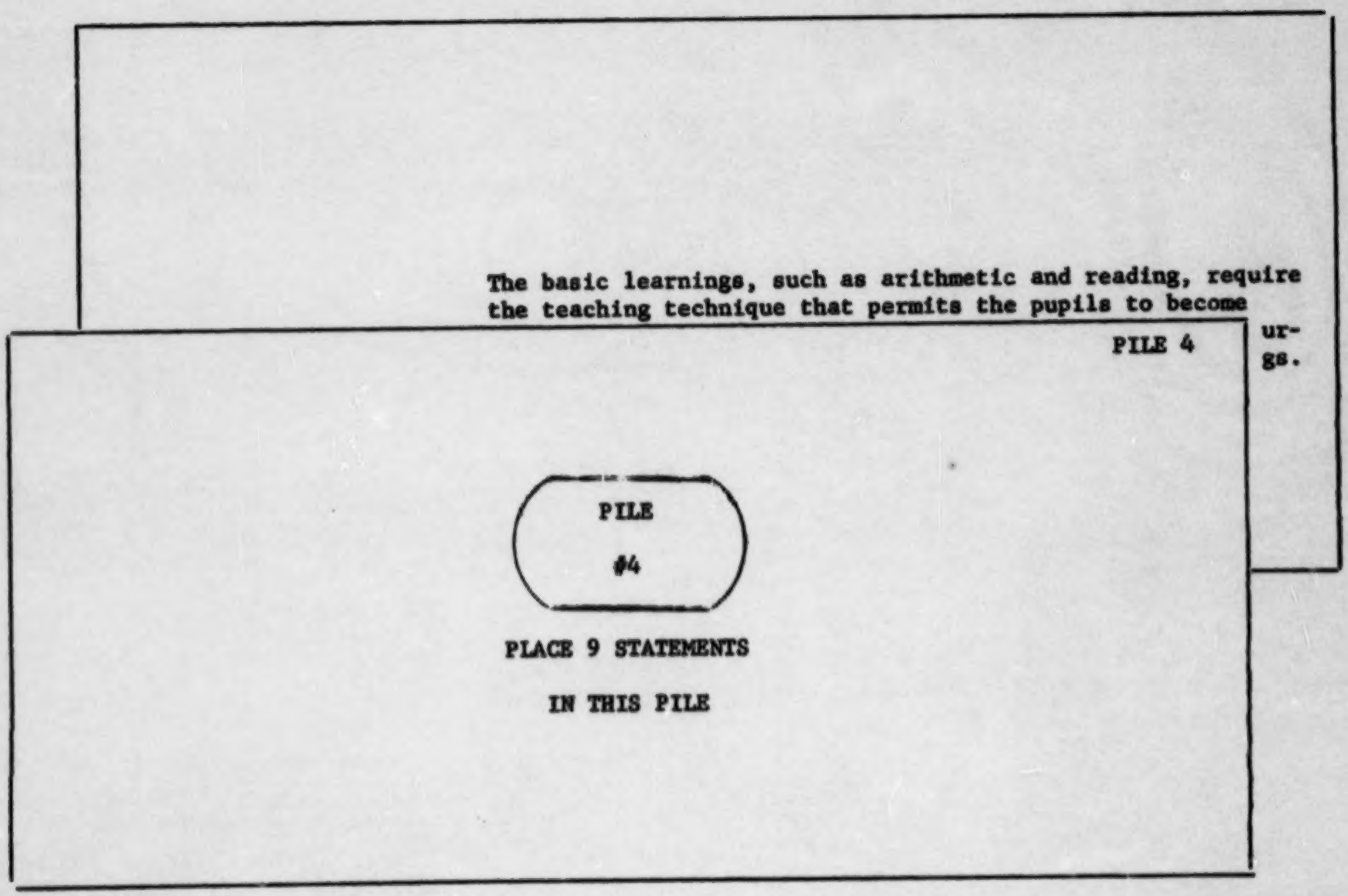
Pile	1	2	3	4	5	6	7	8	9
Score	9	8	7	6	5	4	3	2	1

SCORE MATRIX

cell / row	ad 1	ae 2	af 3	cd 4	ce 5	cf 6	row
1							1
2							2
3							3
4							4
5							5
6							6
7					4		7
8							8
9							9
SUMS							270

FIGURE 12

ILLUSTRATING FORMAT OF INDIVIDUAL Q-SORT STATEMENT WITH PILE CARD


The basic learnings, such as arithmetic and reading, require
the teaching technique that permits the pupils to become
ur-
gs.
PILE 4
PILE
#4
PLACE 9 STATEMENTS
IN THIS PILE